U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Low Visibility Taxiway Lighting Systems | **Date:** 9/1/98 | **AC No.:** 150/5340-28
Initiated by: AAS-200 | **Change:**

1. PURPOSE. This circular describes the standards for design, installation, and maintenance of low visibility taxiway lighting systems, including taxiway centerline lights, stop bars, runway guard lights, and clearance bars.

2. CANCELLATION. Advisory Circular (AC) 150/5340-19, *Taxiway Centerline Lighting System,* dated November 14, 1968, is cancelled.

3. PRINCIPAL CHANGES. The contents of AC 15015340-l 9 have been incorporated herein and revised according to the following principal changes:

a. The visibility limit for the closer spacing of taxiway centerline lights was raised from 1,000 ft (304 m) Runway Visual Range (RVR) to 1,200 ft (365 m) RVR.

b. The,color of taxiway centerline lights for runway exits has been changed to alternating green and yellow.

c. Flashing yellow runway guard lights have replaced steady-burning yellow clearance bars (previously known as hold bars) at runway holding positions.

d. Installation criteria for the L-852E and F taxiway intersection centerline fixtures have been included.

e. The location of clearance bars at taxiway intersections has been changed to agree with the location of taxiway/taxiway intersection markings specified in AC 150/5340- 1, ***Standards for Airport Markings.***

f. The restriction has been removed to allow taxiway centerline lights to be installed on runways for operations below 1,200 ft (365 m) RVR.

g. The installation criteria for light bases have been changed to allow for a base and conduit system with one light per transformer.

h. The load curves for the primary and secondary cable have been normalized with those contained in AC 150/5340-24, ***Runway and Taxiway Edge Lighting System.***

4. APPLICATION. The standards contained herein are recommended by the Federal Aviation Administration (FAA) in all applications involving airport development of this nature. The standards are an acceptable means for compliance with 14 Code of Federal Regulations (CFR) Part 139, Certification and Operations: Land Airports Serving Certain Air Carriers. The use of these standards is mandatory for airport projects receiving Federal fund under the airport grant assistance program or the passenger facility charge program.

5. OPERATIONAL CERTIFICATION OF CONTROLLED STOP BARS. In regard to controlled stop bar lighting systems (using **L-852S** and **L-862S** certified fixtures), an additional operational certification may be required for the system under compliance with 14 Code of Federal Regulations (CFR) Part 171, Non-Federal Navigation Facilities. At a minimum, a technical instruction manual for a given airport system shall be required including critical measurement parameters, system operation and maintenance. Unique communication circuits/systems, interfaces (software and hardware), and control consoles shall be included. This verified manual is to ensure the availability of the information to develop maintenance and operational training and certification criteria for the particular system. This information is used to develop post testing requirements for maintaining operational certification after a repair action. This effort is necessitated by the command and control aspect of this safety critical system as an airport procured and maintained system operated by the FAA and by the uniqueness of an airport's equipage and installation.

6. EFFECTIVE DATES. The standards contained herein are effective for all new construction as of the issue date of this AC. Safety will be enhanced by the earliest possible standardization. For the safety benefits resulting from standardization of lighting systems, the FAA expects that all like systems on the airport would be upgraded at the time that any low visibility taxiway lighting system is upgraded as part of new construction. This upgrade would be considered part of the same lighting project. The color of existing taxiway centerline lead off lights should be converted to alternating green/yellow within 6 months of the issue date of this AC, if possible. Yellow steady-burning lights presently installed at taxiway/runway intersections should either be upgraded to meet the requirements for in-pavement runway guard lights or removed (if not required to meet AC 120-57, *Surface* Movement Guidance and *Control* System) within 2 years of the issue date of this AC, if possible.

7. METRIC UNITS. To promote an orderly transition to the metric system, both English and metric units are included in the standards. The metric conversions may not be exact equivalents and, until there is an official changeover to the metric system, the English units will govern.

8. ACKNOWLEDGEMENT. We wish to thank RTCA, Inc. and the members of RTCA Special Committee 184 for their assistance in the development of performance and installation standards for runway guard lights.

9. COMMENTS. Comments or suggestions for improvements on this AC should be sent to:

Manager, Engineering and Specifications Division
Federal Aviation Administration
Attn: AAS-200
800 Independence Ave., S.W.
Washington, DC 20591

10. COPIES OF THIS AC. AAS-200 is in the process of making copies of ACs in their purview available to the public through the Internet. As the ACs are revised, they will be placed on the Internet at: **http://www.faa.gov**. To get to the AC area, select "Airports" followed by "Advisory Circulars." A printed copy of this and other ACs may be ordered through the AC Checklist, which is available on the Internet at: **http://www.faa.gov/abc/ac-chklst/actoc.htm**.

David L. Bennett
Director, Office of Airport Safety and Standards

TABLE OF CONTENTS

1. INTRODUCTION. Taxiway centerline lights, runway guard lights (RGLs), stop bars, and clearance bars are designed to facilitate taxiing during low visibility conditions.

a. Taxiwav Centerline lights. Taxiway centerline lights provide taxi guidance between the runway and apron areas.

b. Runway Guard Lights. RGLs provide a distinctive warning to anyone approaching the runway holding position that they are about to enter an active runway. It is recommended that RGLs not be operated when the associated runway is closed to landing and takeoff operations.

c. Stop Bars. Stop bars provide a distinctive "stop" signal to anyone approaching an active low visibility runway. Controlled stop bars are used to permit access to the active runway. Uncontrolled stop bars protect the active runway at taxiway/runway intersections that are not part of the low visibility taxi route. Stop bars are required for operations below 600 feet (183 m) RVR at illuminated taxiways that provide access to the active runway.

d. Clearance Bars. Clearance bars serve two purposes:

(1) In low visibility, clearance bars warn pilots and vehicle drivers that they are approaching a hold point (other than a runway holding position). They are installed at designated hold points on the taxiway for operations below 600 feet (183 m) RVR.

(2) At night and in inclement weather, clearance bars warn pilots and vehicle drivers that they are approaching an intersecting taxiway. They are generally installed at taxiway intersections where the taxiway centerline lights do not follow the taxiway curve, as depicted in Appendix 2, Figure 1, and taxiway edge lights are not installed.

2. IMPLEMENTATION CRITERIA. It is recommended that airports served by scheduled Air Carriers authorized to conduct operations when the visibility is less than 1,200 feet (365 m) RVR, install the various low visibility lighting systems according to the criteria contained in AC 120-57.

In addition, taxiway centerline lights and runway guard lights should be installed where a taxiing problem exists. Such problems include, but are not limited to, the following:

a. Runway Incursions. Runway guard lights should be installed at taxiway/runway intersections where enhanced conspicuity of the runway holding position is required.

b. Complex Taxiwav Configurations. Taxiway centerline lights should be installed to improve guidance for complex taxiway configurations. Edge lights may be installed in addition to centerline lights if warranted by operational and weather conditions.

c. Apron Areas. Taxiway centerline lights should be installed in apron areas where other lighting may cause confusion to taxiing or parking operations.

3. TAXIWAY CENTERLINE LIGHTING SYSTEM CONFIGURATION.

a. General. The taxiway centerline lighting system consists of uni- or bidirectional in-pavement lights installed alongside the taxiway centerline marking. See AC 120-57 for criteria on the application of taxiway centerline lighting systems below 1,200 feet (365 m) RVR.

b. Color-Coding. Taxiway centerline lights which are visible to persons exiting the runway ("lead off' lights) are color-coded to warn pilots and vehicle drivers that they are within the runway safety area or

ILS/MLS critical area, whichever is more restrictive. Alternate green and yellow lights are installed (beginning with green) from the runway centerline to one centerline light position beyond the runway holding position or ILS/MLS critical area holding position, whichever is more critical. If this would result in an odd number of color-coded lights, the first two taxiway centerline lights on the runway should be green. Taxiway centerline lights which cross a runway are color-coded from the runway centerline to one centerline light position beyond the runway holding position or ILS/MLS critical area holding position, whichever is more critical. The first yellow light may be one position before or one position beyond the runway centerline to avoid having two adjacent lights of the same color, as shown in Appendix 2, Figure 2. All other taxiway centerline lights are green.

c. Longitudinal and Lateral Suacinq. The lights are spaced longitudinally as described in Table 1 for minimum authorized operations above and below 1,200 feet (365 m) RVR. Fixtures should be installed so that their nearest edge is approximately 2 feet (610 mm) from any rigid pavement joint. Allow a tolerance, for individual fixtures, of ±10 percent of the longitudinal spacing specified to avoid undesirable spots. However, a tolerance of ±2 ft (610 mm) should be allowed for fixtures spaced at 12.5 ft (4 m). Displace centerline lights laterally a maximum of 2 feet (610 mm) (to the nearest edge of the fixture) to avoid rigid pavement joints and to ease the job of painting the centerline marking. Apply this lateral tolerance consistently to avoid abrupt and noticeable changes in guidance; i.e., no "zigzagging" from one side of the centerline to the other.

NOTE: Taxiway fillets are designed in relation to the centerline of the curve, and therefore, the location of the centerline marking. Displacement of taxiway centerline lights 2 feet (6 10 mm) to the inside of a curve does not necessitate enlargement of the fillet.

Table 1. Longitudinal Dimensions

	Maximum Longitudinal Spacing	
	1,200 Feet (365 m) RVR and Above	Below 1,200 Feet (365 m) RVR
Radius of Curved Centerlines		
75 ft (23 m) to 399 ft (121 m)	25 ft (7 m)	12.5 ft (4 m)
400 ft (122 m) to 1199 ft (364 m)	50 ft (15 m)	25 (7 m)
21200 ft (365 m)	100 ft (30 m)	50 ft (15 m)
Acute-Angled Exits (See Appendix 2, Figure 3 and AC 150/5300-13)	50 ft (15 m)	50 ft (15 m)
Straight Segments	* 100 ft (30 m)	*50 ft (15 m)

* Short straight taxiway segments may require shorter spacing in accordance with Paragraph 3h.

d. Acute-Angled Exits. For acute-angled exits, taxiway centerline "lead off" lights begin 200 feet (60 m) prior to the point of curvature of the designated taxiway path, as shown in Appendix 2, Figure 3. The row of taxiway centerline lights may be offset laterally up to 2 feet (610 mm) on either side of the taxiway centerline marking, but should not be installed closer than 2 feet (610 mm) to the row of runway centerline lights.

e. Taxiway/Runway Intersections Other Than Acute-Angled Exits. For these exits which lie on low visibility taxi routes, taxiway centerline "lead off' lights begin at the point of curvature on the runway if the runway has approach or departure minimums below 600 ft (183 m) RVR. "Lead off' lights are recommended below 1,200 ft (365 m) RVR. (Extra "lead off' lights should not be installed before the point of curvature on the runway because it would erode the visual distinction between acute-angled exits and other exits.) Taxiway centerline "lead on" lights should extend to the point of tangency on the runway, as shown in Appendix 2, Figure 4b, if the runway has departure minimums below 600 ft (183 m) RVR. "Lead on" lights are recommended for departure minimums below 1,200 ft (365 m) RVR. Where operations are not conducted below 1,200 ft (365 m) RVR, neither taxiway centerline "lead on" nor "lead off' lights should be installed within the confines of the runway. Further, if the taxiway is perpendicular to, and dead-ends into, the runway, the taxiway centerline light nearest the runway should be installed 150 feet (46 m) from the centerline of the runway where "long-bodied" aircraft are involved. For this purpose, "long-bodied" refers to aircraft whose distance between the nose gear and main gear is approximately 60 feet (18 m) or greater.

f. Taxiwavs Crossing a Runway. At airports where operations below 600 ft (183 m) RVR are conducted, taxiway centerline lights should continue across a runway if they are installed on a designated low visibility taxi route. It is recommended that centerline lights continue across a runway for operations below 1,200 ft (365 m) RVR where the taxiway is an often used route or there is a jog in the taxiway at the intersection with the runway. Otherwise, taxiway centerline lights should not extend into the confines of the runway.

g. Taxiwavs Crossing Another Taxiwav. Continue taxiway centerline lighting across the intersection when a taxiway intersects and crosses another taxiway. If the fillets at a given taxiway intersection meet the design criteria of AC 150/5300-13, *Airport Design,* and the taxiway centerline markings follow the taxiway curves in accordance with AC 150/5340-1, then taxiway centerline lights should be installed as shown in Appendix 2, Figure 5. Otherwise, they should be installed as shown in Appendix 2, Figure 1. See Paragraph 7a for criteria on the installation of taxiway intersection centerline lights and clearance bars.

h. Short Straight Taxiway Segments. There should be a minimum of four taxiway centerline lights installed on short straight taxiway segments.

i. Orientation of Light Beam for Taxiwav Centerline Lights. Taxiway centerline lights should be oriented as follows, with a horizontal tolerance of ±1°.

(1) On Straight Portions. On all straight portions of taxiway centerlines, the axis of the light beam should be parallel to the centerline of the taxiing path.

(2) On Curved Portions (Excluding Acute-Angled Exits) with Standard Fillets. Orient the axes of the two beams of bidirectional lights parallel to the tangent of the nearest point of the curve designated as the true centerline of the taxiway path. Orient the axis of a unidirectional light beam so that it is "toed-in" to intersect the centerline at a point approximately equal to four times the spacing of lights on the curved portion. Measure this spacing along the chord of the curve. See Appendix 2, Figure 6.

(3) On Curved Portions (Excluding Acute-Angled Exits) with Non-Standard Fillets. See Appendix 2, Figure 1, for orientation and configuration of bidirectional and unidirectional fixtures for taxiway intersections, taxiways crossing a taxiway or a runway, and taxiway curves.

(4) Acute-Angled Exits. Orient the axis of a unidirectional light beam so that it is "toed-in" to intersect the centerline at a point approximately equal to four times the spacing of lights on the curved portion. Measure this spacing along the chord of the curve. Orient the axes of the two

beams of bidirectional lights parallel to the tangent of the nearest point of the curve designated as the true centerline of the taxiing path.

j. Supplemental Taxiway Edge Lights and Elevated Edge Reflectors.
Refer to AC 120-57 for criteria on supplementing taxiway centerline lights with taxiway edge lights (L-861T) or elevated edge reflectors (L-853) for low visibility operations. For higher visibilities, where taxiway edge lights are not installed, taxiway centerline lighting should be supplemented with elevated edge reflectors installed adjacent to the taxiway edge on paved fillets and on curves of radii less than 800 feet (244 m) (measured to the taxiway centerline). Supplemental edge lights may be installed to aid taxi operations when centerline lights are obscured by snow. Space edge lights and reflectors in accordance with the requirements of AC 150/5340-24. Supplemental reflectors may be used in ramp areas.

4. RUNWAY GUARD LIGHT CONFIGURATION.

a. General. Elevated and in-pavement runway guard lights (RGLs) serve the same purpose and are generally not both installed at the same runway holding position. However, if snow could obscure in-pavement RGLs or there is an acute angle between the holding position and the direction of approach to the holding position, it may be advantageous to supplement in-pavement RGLs with elevated RGLs. Each elevated RGL fixture consists of two alternately illuminated, unidirectional yellow lights. In-pavement RGLs consist of a row of alternately illuminated unidirectional yellow lights. Refer to AC 120-57 for criteria on the application of RGLs below 1,200 feet (365 m) RVR.

b. Location of In-Pavement Runway Guard Lights. In-pavement RGLs are centered on an imaginary line which is parallel to, and 2 feet (610 mm) from, the holding side of the runway holding position marking, as shown in Appendix 2, Figure 7. The lights may vary from this imaginary line up to ±2 inches (±50 mm) in a direction perpendicular to the holding position marking. Holding position marking locations are described in AC 150/5340-1. If a conflict with rigid pavement joints occurs, both the runway holding position marking and the RGLs may be moved away from the runway the minimum distance required to resolve the conflict. If other markings (e.g., geographical position markings) are installed, they should be moved as well.

(1) Lateral Spacing - Preferred Method. The lights are spaced across the entire taxiway, including fillets, holding bays, etc., on intervals of 9 feet, 10 inches (3 m), ±2 inches (±50 mm), center-to-center, as shown in Appendix 2, Figure 7. The lights are spaced in relation to a reference fixture which is installed in-line (longitudinally) with existing or planned taxiway centerline lights. However, it is not intended that the reference fixture replace a taxiway centerline light. If a conflict between the reference fixture and a centerline light occurs, the reference fixture may take the place of an existing centerline light and a new centerline light should be installed in accordance with the criteria in Paragraph 3c. If the holding position marking is intersected by multiple taxiway centerline markings, the reference fixture should be set at the centerline which is normally used most often. A fixture whose outboard edge falls at a point less than 2 feet (6 10 mm) from the defined edge of the taxiway (outboard edge of the taxiway marking) may be omitted. Individual fixtures may be moved laterally a maximum of ±1 foot (305 mm) in order to avoid undesirable spots, i.e. conduit, etc.

NOTE: Generally, undesirable spots must be avoided by a total of 2 feet (610 mm). If this cannot be met by applying the aforementioned ±1 foot (305 mm) tolerance, then the following alternate method should be used.

(2) Lateral Spacing - Alternate Method. The following alternate method of spacing the lights should be followed if it is not possible to meet the preferred method specified in Paragraph 4b(1). The lights are spaced across the entire taxiway, including fillets, holding bays, etc. If it is possible to meet 4b(1) by allowing the reference fixture to be moved any amount laterally,

then that method should be used. Otherwise, the lights should be spaced as uniformly as possible with a minimum spacing of 8 feet (2.4 m) and a maximum of 13 feet (4 m).

c. Light Beam Orientation for In-Pavement Runway Guard Lights. The L-868 bases for in-pavement runway guard lights should be installed such that a line through one pair of bolt holes on opposite sides of the base is parallel to the runway holding position marking. Each fixture is installed so that the light beam faces away from the runway and is perpendicular to the runway holding position marking within a tolerance of ±1°. For some pavement configurations, it may be necessary to orient the lights at some angle to the marking. To accomplish this, install a 12 bolt-hole base using the above procedure. This allows the light fixtures to be adjusted 30 degrees left or right, as required. See Appendix 2, Figure 8 for typical examples.

d. Location of Elevated Runway Guard Lights. Elevated RGLs are collocated with the runway holding position marking and are normally installed on each side of the taxiway. Generally, elevated runway guard lights should be located as close as practical to the taxiway edge to maximize their conspicuity. The distance from the defined taxiway edge to the near side of an installed light fixture should be 10 to 17 feet (3 to 5 m). In order to avoid undesirable spots, the RGL may be moved up to 10 feet (3 m) farther from the runway, but may not be moved toward the runway, as shown in Appendix 2, Figure 9. If a stop bar is installed at the runway holding position, the elevated RGL should be located at least 3 feet, 6 inches (1 m) outboard of the elevated stop bar light. The RGL should not be located so as to interfere with the readability of the runway holding position sign.

e. Light Beam Orientation for Elevated Runway Guard Lights. RGLs should be oriented to maximize the visibility of the light by pilots of aircraft approaching the runway holding position. In general, the orientation should be specified by the design engineer to aim the center of the light beam toward the aircraft cockpit, when the aircraft is between 150 feet (45 m) and 200 feet (60 m) from the holding position, along the predominant taxi path to the holding position. The vertical aiming angle should be set between 5 degrees and 10 degrees above the horizontal. The designer should specify aiming of the lights such that the steady burning intensity at all viewing positions between 150 feet (45 m) and 200 feet (60 m) from the holding position is at least 300 cd when operated at the highest intensity step. (Refer to AC 150/5345-46, Specification *for* Runway and *Taxiway Light Fixtures,* for specifications for the light intensity and beamspread of the L-804 RGL fixture.) If these criteria cannot be met for all taxi paths to the holding position, consideration should be given to the use of multiple fixtures aimed to adequately cover the different taxi paths, the use of in-pavement fixtures to increase the viewing coverage, or aiming the single fixtures on each side of the holding position to optimize the illumination of the predominant taxi path.

5. STOP BAR CONFIGURATION.

a. General. A stop bar consists of a row of unidirectional in-pavement red lights and an elevated red light on each side of the taxiway. Refer to AC 120-57 for criteria on the application of stop bars.

b. Location of In-Pavement Stop Bar Lights. In-pavement stop bar lights are centered on an imaginary line which is parallel to, and 2 feet (610 mm) from, the holding side of the runway holding position marking, as shown in Appendix 2, Figure 9. The lights may vary from this imaginary line up to ±2 inches (±50 mm) in a direction perpendicular to the holding position marking. Holding position marking locations are described in AC 150/5340-l. If a conflict with rigid pavement joints occurs, both the runway holding position marking and the stop bar lights may be moved away from the runway the minimum distance required to resolve the conflict. If other markings (e.g., geographical position markings) are installed, they should be moved as well.

(1) Lateral Spacing - Preferred Method. The lights are spaced across the entire taxiway, including fillets, holding bays, etc., on intervals of 9 feet, 10 inches (3 m), ±2 inches (±50 mm), center-to-center, as shown in Appendix 2, Figure 9. The lights are spaced in relation to a reference

fixture which is installed in-line (longitudinally) with existing or planned taxiway centerline lights. However, it is not intended that the reference fixture replace a taxiway centerline light. If a conflict between the reference fixture and a centerline light occurs, the reference fixture may take the place of an existing centerline light and a new centerline light should be installed in accordance with the criteria in paragraph 3c. If the holding position marking is intersected by multiple taxiway centerline markings, the reference fixture should be set at the centerline which is used most. A fixture whose outboard edge falls at a point less than 2 feet (610 mm) from the defined edge of the taxiway (outboard edge of the taxiway marking) may be omitted. Individual fixtures may be moved laterally a maximum of ±1 foot (305 mm) in order to avoid undesirable spots, i.e. conduit, etc.

NOTE. Generally, undesirable spots must be avoided by a total of 2 feet (6 10 mm). If this cannot be met by following the aforementioned ±1 foot (305 mm) allowance, then the below alternate method should be used.

(2) Lateral Spacing - Alternate Method. The following alternate method of spacing the lights should be followed if it is not possible to meet the preferred method specified in Paragraph 5b(1). The lights are spaced across the entire taxiway, including fillets, holding bays, etc. If it is possible to meet 5b(1) by allowing the reference fixture to be moved any amount laterally, then that method should be used. Otherwise, the lights should be spaced as uniformly as possible with a minimum spacing of 8 feet (2.4 m) and a maximum of 13 feet (4 m).

c. Light Beam Orientation for In-Pavement Stop Bar Lights. The L-868 bases for in-pavement stop bar lights should be installed such that a line through one pair of bolt holes on opposite sides of the base is parallel to the runway holding position marking. Each fixture is installed so that the axis of the light beam faces away from the runway and is perpendicular to the marking with a tolerance of ±1°. In some instances, it may be necessary to aim the lights at some angle to the marking. To accomplish this, install a 12 bolt-hole base using the above procedure. This allows the light fixtures to be adjusted 30 degrees left or right, as required. See Appendix 2, Figure 8 for typical examples.

d. Location of Elevated Stop Bar Lights. Elevated stop bar lights are installed in-line with the in-pavement stop bar lights on each side of the taxiway. They are located not more than 10 feet (3 m) from the defined edge of the taxiway. For airports that perform any snow removal operations, if taxiway edge lights are present, the elevated stop bar light should not be installed closer to the taxiway edge than the line of taxiway edge lights. This is to help prevent the elevated stop bar light from being struck by snow removal equipment. In order to avoid conflicts with taxiway edge lights or undesirable spots, the elevated stop bar lights may be moved up to 10 feet (3 m) farther from the runway, but may not be moved toward the runway. See Appendix 2, Figure 9.

e. Light Beam Orientation for Elevated Stop Bar Lights. Elevated stop bar lights should be oriented to maximize the observability of the light by pilots of aircraft approaching the runway holding position. In general, the orientation should be specified by the design engineer to aim the axis of the light beam toward the aircraft cockpit, when the aircraft is between 120 feet (37 m) and 170 feet (52 m) from the holding position, along the predominant taxi path to the holding position. The vertical aiming angle should be set between 5 degrees and 10 degrees above the horizontal. The designer should specify aiming of the lights such that the axis of the light beams intersect the primary taxiway centerline between 120 feet (37 m) and 170 feet (52 m) from the holding position.

6. COMBINATION IN-PAVEMENT STOP BAR AND RUNWAY GUARD LIGHTS. At the option of the airport, combination in-pavement stop bar and RGL lights may be installed in lieu of standard in-pavement stop bar fixtures. This option is provided to allow for the provision of in-pavement RGLs above 1,200 feet (365 m) RVR and a stop bar below 1,200 feet (365 m) RVR for a given location. (A typical application includes taxiways > 150 feet (46 m) wide which lie on a designated low visibility taxi route for operations below 600 feet (183 m) RVR.) The circuit should be designed so that the yellow and red lights cannot both be "on" at the same time. Combination stop bar/RGL fixtures are installed in the same location and with the same light beam

orientation as in-pavement stop bars. Refer to AC 120-57 for further criteria on the application of combination stop bar/RGLs below 1,200 feet (365 m) RVR.

7. CLEARANCE BAR CONFIGURATION.

a. General. A clearance bar consists of a row of three in-pavement yellow lights to indicate a low visibility hold point. The fixtures are normally unidirectional but may be bidirectional depending upon whether the hold point is intended to be used in one or two directions. Refer to AC 120-57 for criteria on the application of clearance bars.

In addition, with the below exceptions; clearance bars are installed (without regard to visibility) at a taxiway intersection with non-standard fillets or where the taxiway centerline lights do not follow curves at intersections, as depicted in Appendix 2, Figure 1. Clearance bars installed for this purpose consist of unidirectional fixtures.

(1) Clearance bars may be omitted if taxiway edge lights are installed at the intersection in accordance with AC 150/5340-24.

(2) Clearance bars at a "T" or "+" shaped taxiway/taxiway intersection may be substituted by or supplemented with an omnidirectional yellow taxiway intersection light (L-852E or F, as appropriate) installed near the intersection of the centerline markings if the angle between the centerlines of any two adjacent segments of the pavement is 90 degrees ± 10 degrees.

(3) The clearance bar located on an exit taxiway may be omitted if it would be located before, or within 200 feet (6 1 m) beyond, a runway holding position (as viewed while exiting the runway).

b. Location of a Clearance Bar Installed at a Low Visibility Hold Point. A low visibility hold point consists of a taxiway/taxiway holding position marking, a geographic position marking, and a clearance bar. However, hold points are not necessarily located at taxiway/taxiway intersections. In-pavement clearance bar lights are centered on an imaginary line which is parallel to, and 2 feet (610 mm) from, the holding side of the taxiway/taxiway holding position marking, as shown in Appendix 2, Figure 10. The lights may vary from this imaginary line up to ±2 inches (±50 mm) (perpendicular to the holding position marking). If a conflict occurs with rigid pavement joints or other undesirable spots, the taxiway/taxiway holding position marking, geographic position marking, and the clearance bar may all be moved longitudinally any amount necessary to resolve the conflict. However, if the hold point is located at a taxiway/taxiway intersection, the aforementioned items should all be moved away from the intersecting taxiway the minimum necessary to resolve the conflict. If a conflict occurs between the center fixture in the clearance bar and a centerline light, the center fixture may take the place of an existing centerline light, and a new centerline light should be installed in accordance with the criteria in paragraph 3 c.

c. Location of a Clearance Bar Installed at a Taxiwav Intersection.
A clearance bar installed at a taxiway intersection is located in accordance with the criteria in Paragraph 7b if that location is established as a hold point and taxiway/taxiway holding position markings are present. Otherwise, the clearance bar should be located in the same manner as if the holding position marking were present. This allows room for the possible future installation of the marking.

NOTE: Taxiway/taxiway holding position marking locations are described in AC 150/5340-1.

(1) Lateral Spacing. The center light of the clearance bar is installed in-line with existing or planned taxiway centerline lights. The two remaining lights are installed outboard of the center fixture on 5-foot (1.5 m) intervals, center-to-center, as shown in Appendix 2, Figure 1,

Clearance Bar Detail. The outboard fixtures may be moved laterally a maximum of ±1 foot (305 mm) in order to avoid undesirable spots, i.e. conduit, etc.

d. Light Beam Orientation for Clearance Bars. The axis of the light beam for each fixture should be parallel to the centerline of the designated taxiway path with a tolerance of ±1°.

8. DESIGN.

a. General. The installation of in-pavement L-868 light bases and conduit should be done, if possible, while the pavement is under construction or when an overlay is made. Installation of light bases after paving is very costly and requires a lengthy shutdown of the taxiway or runway.

b. Layout. A design drawing should be developed prior to construction, which shows the dimensional layout of each lighting system to be installed. Correlate this design with current airport drawings to utilize available ducts and utilities and to avoid conflict with existing or planned facilities.

c. In-Pavement Light Fixtures and Electrical Cables. Design each in-pavement lighting system for one of the conditions listed below:

(1) New rigid navements and new flexible pavements. Taxiway centerline lighting and clearance bar systems installed in new pavement should be designed for installation on L-868 bases with one L-830 isolation transformer provided for each light. Cable is run through conduit between light fixtures.

Use of a base and conduit system will reduce downtime and repair costs when the underground circuits require maintenance.

In-pavement RGLs and stop bars should either: 1) be direct-mounted fixtures with wire connections made in L-869 junction boxes or, 2) be installed on L-868 bases with wire connections made in the bases.

(2) Pavements Being Overlaved. A base and conduit system as described in 8c(1), above, may be used. Two-section bases and spacer rings to reach proper elevation may be required.

(3) Existing Pavements. Provide recesses or holes for direct-mounted light fixtures or fixtures installed on bases. Isolation transformers and local control devices are located at the side of the taxiway. Up to four taxiway centerline lights or all three clearance bar lights may be operated from a single L-830 isolation transformer. No. 10 AWG wire is run between the transformer and the lights through shallow sawed wireways (saw kerfs) in the pavement surface. See Appendix 2, Figure 11.

Alternatively, L-868 bases and conduit systems for taxiway centerline lighting and clearance bar systems may be retrofitted into existing pavements. Isolation transformers and/or local control devices, if any, are located within the bases.

d. Elevated Light Fixtures. Elevated stop bar lights may be mounted either on L-867 bases or stakes. Elevated RGLs should only be mounted on L-867 bases because of the large bending moment exerted on the mounting system in high jet-blast areas.

e. General Circuit Design and Control Concept for Airports With Onerations Below 1.200 ft (365 m) RVR. As the weather deteriorates below 1,200 ft (365 m) RVR, ATC personnel will declare SMGCS procedures to be in effect and will activate the "below 1,200 ft RVR" system on the airport lighting control panel. All low visibility lighting systems necessary for below 1,200 ft (365 m) RVR operations, as detailed in AC 120-57, will be turned on. It is recommended that taxiway centerline lights and edge lights on taxiways that are not designated as low visibility taxi routes be turned off.

For airports with operations below 600 ft (183 m) RVR, all controlled and uncontrolled stop bars will be turned on when the "below 1,200 ft RVR" system is activated. The stop bar control panel(s) in the ATCT will become active at that time. There should be a provision for all the stop bars serving an active low visibility runway to be turned off from the stop bar control panel. See AC 150/5345-3, ***Specification for L-821 Panels for Remote Control of Airport Lighting.***

f. Taxiwav Centerline Lighting and Clearance Bar Systems.

(1) Fixture Selection. L-852C (narrow beam), L-852D (wide beam), and L-852F (omnidirectional) fixtures are installed on taxiways which are designated as low visibility taxi routes below 1,200 ft (365 m) RVR in accordance with AC 120-57. Otherwise, L-852A (narrow beam), L-852B (wide beam), and L-852E (omnidirectional) taxiway centerline fixtures should be installed.

The appropriate L-852B or L-852D bidirectional fixture should be installed at the intersections of taxiways with taxiways, taxiways with runways, taxiways crossing taxiways and/or nmways, at single taxiway curves, and on all straight sections of taxiways off runways up to a distance of at least 400 ft (122 m). The appropriate L-852B or L-852D unidirectional fixture should be installed at the intersections of curves on single taxiways. The appropriate L-852A or L-852C fixture should be installed on straight sections of taxiways (excluding straight sections of taxiways off runways to an intersection). See Appendix 2, Figures 1, 3, and 5 for typical lighting configurations. Unidirectional L-852A or L-852C fixtures are normally installed on acute-angled exits. However, bidirectional fixtures may be installed where it is desired to provide guidance for emergency vehicles approaching the runway.

(2) Power Supply. Series circuits for clearance bars and taxiway centerline lighting systems should be powered from an appropriately-sized L-828 or L-829, Class 1, Style 2 (5-step) (preferred) or Style 1 (3-step) constant current regulator. Brightness control is achieved by varying the output current. Determine the appropriate size and number of regulators for a specific 6.6 ampere series lighting circuit by using the curves shown in Appendix 2, Figure 12.

(3) Secondary Circuit Design for Taxiwav Centerline Lights. Example design calculations for the secondary circuit for taxiway centerline lights is shown in Figure 12. The example calculations assume four fixtures are installed on the secondaries of each isolation transformer. Other designs/configurations will require individual analysis. Manufacturers' recommendations should be sought when sizing components.

(4) Circuit Design for Clearance Bars and Low Visibilitv Taxi Routes.

(a) Clearance bars. It is recommended that clearance bars installed at low visibility hold points have the capability of being switched "off' in visibilities above 1,200 ft (365 m) RVR. This can be accomplished through the use of local control devices or circuit selector switches. Other clearance bars should be "on" whenever the taxiway centerline lights are "on." Note: If a clearance bar is installed for both purposes described in Paragraph 7a, then they should be "on" whenever the taxiway centerline lights are "on."

(b) Taxiwavs Designated as Low Visibilitv Taxi Routes Below 1,200 ft (365 m) RVR . It is strongly recommended that new taxiway centerline lighting circuits be designed with close consideration of the low visibility taxi routes designated in the airport's SMGCS plan for operations below 1,200 ft (365 m) RVR and below 600 ft (183 m) RVR. It is advantageous for lights on a low visibility taxi route to be installed on a separate circuit from those that are not. Further, care should be taken to account for the possibility of different low visibility routes above and below 600 ft (183 m) RVR. For example, an uncontrolled stop bar installed for operations below 600 ft (183 m) RVR will be turned on below 1,200 ft (365 m) RVR. This, in effect, eliminates the possibility of that taxiway being considered as part of a low visibility taxi route below 1,200 ft (365 m) RVR. The alternative is to design the taxiway centerline and edge light circuits so that they may be turned off below 600 ft (183 m) RVR; thus, eliminating the requirement for an uncontrolled stop bar.

(5) Taxiwav Centerline Lighting and Clearance Bar Control Methods.

(a) General. Where possible, use simple switching to energize and de-energize the circuits or to control lamp brightness.

(b) Remote Control. Remote control systems are controlled from a panel located in the cab of the control tower or at some other location. The control panel recommended in AC 150/5345-3 should be used. This panel controls operating relays located in the vault, from which power is supplied to the taxiway centerline lighting regulators.

There are many methods of providing for the remote control of L-828/L-829 constant current regulators, L-847 circuit selector switches, etc. Such methods may include ground-to-ground radio control (see AC 150/5345-49, Specification L-854, Radio Control Equipment), or copper or fiber optic control lines. Control signals may be digital or analog. Whatever the method used, the airport design engineer is responsible for ensuring that the control system is reliable and that electromagnetic interference does not cause unintended switching of the lighting system.

Two common methods used to control constant current regulators and other equipment are described below. They may be used as a basis for the design of more complex control systems.

1 120 Volts AC. Where the distance between the remote control panel and the vault is not great enough to cause excessive voltage drop in the control leads, use the standard control panel switches to operate the control relays directly. Operating relays supplying power to the taxiway centerline regulators must have coils rated for 120 volts AC. A No. 12 AWG control cable should be used to connect the control panel to the power supply equipment in the vault. Use the curves in Appendix 2, Figure 13, to determine the maximum permissible separation between the control panel and the vault for 120-volt AC control. Special pilot low burden auxiliary relays, having proper coil resistance to reduce control current, may be used to obtain additional separation distance with 120-volt AC control circuits. It may be advantageous to use these relays for expanding existing 120-volt AC control circuits. Appendix 2, Figures 14, 15, and 16 illustrate typical applications of 120-volt AC control circuits.

2 48 Volts DC. Where the distance between the control panel and the vault would cause excessive control voltage drop, a low voltage (48-volt DC) control system should be used. In such a system, remote control panel switches activate sensitive pilot relays, such as those specified in AC 150/5345-13, ***Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of*** Airport ***Lighting Circuits,*** which, in turn, control the regulator relays. Use an appropriately sized cable, of a type which is suitable for direct earth burial, to connect the control panel to the pilot relays. The DC control system is adequate for up to 7900 feet separation between control point and vault. For typical application details, see Appendix 2, Figures 17 and 18 and AC 150/5345-3.

(6) Sectionalizing of Circuits for Traffic Control.

(a) General. The taxiway centerline lighting system may be sectionalized so as to delineate specific routes for ground movements and to control traffic where such control is determined necessary by consultation with the air traffic facility manager and airport sponsor. In order to control taxiway centerline lighting segments, taxiway centerline lighting systems may either be designed with many small circuits or with fewer circuits covering multiple taxiway segments. If portions of larger circuits need to be switched on and off separately from the remainder of the circuit, local control devices or L-847 circuit selector switches may be used. Note: Constant current regulator manufacturers should be consulted for information on the recommended minimum load for their regulators.

(b) Local Control Devices. Segments of the taxiway centerline lighting system may be turned on and off by the transmission of control commands to local control devices via some means, e.g., power line carrier or separate control cable. Individual lights or groups of lights may be installed on each local control device, in accordance with the manufacturer's recommendations.

(c) Selector Switch. A circuit selector switch may be used to select short segments of separate taxiway centerline lighting circuits supplied from the same regulator. This switch can be remotely controlled from separately installed circuit breakers or an L-82 1 control panel conforming to AC 150/5345-3. Use the appropriate selector switch conforming to AC 150/5345-5, Circuit Selector *Switch,* for the number of individual loops to be controlled.

1 Combination of Selector Switches. Combinations of selector switches may be used to remotely control more than four series loops.

2 Maximum Power. The selector switch described in AC 150/5345-5 is designed for a maximum of 5000 volts, limiting the maximum connected load on 6.6-ampere series circuits to approximately 30 KW. For application of the selector switch, see Appendix 2, Figure 16.

g. Runway Guard Light System.

(1) Power Supply.

(a) General. Elevated RGLs are available as constant current fixtures (Mode 1) or constant voltage fixtures (Mode 2). (See AC 150/5345-46 for further information on the modes.) If Mode 1 elevated RGLs are selected, they should be installed together with in-pavement RGLs on the same dedicated series circuit wherever possible. If Mode 2 elevated RGLs are selected, they should be installed on a dedicated 120 Volt AC or 240 Volt AC circuit and any in-pavement RGLs should be installed on their own series circuit. This provides for independent on/off control for operation during daytime visual meteorological conditions (VMC), if desired, and to allow the RGLs to be turned off when the runway is closed. Furthermore, RGLs often need to be operated at a different intensity setting from that of runway or taxiway edge lights. Dedicated series RGL circuits should be powered from an appropriately sized L-828 or L-829, Class 1, Style 1 (3-step) constant current regulator. Brightness control for series circuits is achieved by varying the output current of the constant current regulator. Brightness control for Mode 2 elevated RGLs is achieved by an integrated or remote sensing device (e.g. photocell) for each fixture.

NOTE: Consult with constant current regulator manufacturers to determine the suitability of specific regulators to power flashing lights.

(b) Elevated Runwav Guard Lights. Where a small number of elevated RGLS are to be installed on an airport, it may be more economical to tap into a nearby circuit than to install a dedicated circuit. However, if the RGLs are intended to be operated during the day for runway incursion prevention purposes, it is not recommended to tap into a nearby circuit because of the increased operating costs of operating the circuit 24-hours a day. Furthermore, a partial circuit load consisting of either elevated or in-pavement RGLs may cause unwanted pulsing of the steady burning lights on the circuit. This effect, if present, will vary with the actual load and type of constant current regulator.

It is generally not recommended to install Mode 1 RGLs on a circuit powered from a 5-step constant current regulator where all 5 steps are available. Elevated RGLs may appear dim when operated on step 1 or 2.

(2) Circuit Design.

(a) Constant Voltage Circuits for Elevated RGLs. It is important that the voltage provided to elevated RGLs be within the tolerances specified by the light manufacturer. The circuit designer should verify the voltage drop of the circuit and make any special provisions necessary to obtain adequate operating voltage at the RGL.

(b) Elevated RGL Electrical Interface. If elevated RGLs will not be monitored, they should be ordered with a lead containing two conductors which terminates with a 2-pin plug. The 2-pin plug mates with the secondary lead of the isolation transformer. If elevated RGLs will be monitored, they should be ordered with a two conductor lead or a five conductor lead, as required by the L-804 manufacturer. Monitoring with a two conductor lead normally involves the use of power line carrier signals. The five conductor lead (2 power, 2 monitoring, 1 case ground) terminates with a 5-pin plug. The mating 5-socket receptacle is either: 1) purchased separately, or 2) provided with a separately purchased control and monitoring device, i.e., as would be provided in a power line carrier system. A 5-socket receptacle and lead should be used to interface with the 5-pin plug. The method of connecting the two leads is at the discretion of the elevated RGL manufacturer.

(c) In-Pavement RGL Control Methods. There are two typical methods used to control in-pavement RGL systems.

1 Method 1. In the first method, a power line carrier system is used. Two common methods for connecting a power line carrier system are shown in Appendix 2, Figures 19 and 20. In Figure 19, a remote control device is connected to each in-pavement RGL. Communication occurs on the series circuit between each remote control device and a master control device located in the airfield lighting vault. In Figure 20, a remote control device is connected to every fourth light fixture to prevent adjacent light fixtures from becoming inoperative in the event of the failure of a single control device.

Note: The manufacturer of the power line carrier system should be consulted for any equipment or environment limitations, e.g., the condition of the lighting cables, presence of moisture, etc.

2 Method 2. In the second method, a separate communication connection (copper wire, fiber optic cable, etc.) is made to a remote I/O control device located adjacent to the in-pavement RGL system as shown in Appendix 2, Figure 2 1.

This is typically a programmable logic controller (PLC). The communication link is typically connected to a separate vault computer. Control and monitoring terminals should be provided in the vault computer. The vault computer should have a monitoring link to the constant current regulator in order to verify that current is present on the output of the regulator. As an option, the control and monitoring terminal blocks (or other interface device, as required) may be located in the remote I/O control device.

2 A terminal block (see Appendix 2, Figure 22) or other interface device should be provided in the master control device or vault computer at which a closed contact is made to activate all in-pavement RGL systems which are connected to the constant current regulator. When the "on" signal is activated, all RGL systems should turn on and automatically begin pulsing. If electronic monitoring is used, a separate "caution" and "fault" terminal block should be used to activate the "caution" and "fault" signals. The "caution" signal will be activated if at least one in-pavement RGL or if a single local control device or I/O control module fails. The "fault" signal will be activated if two adjacent in-pavement RGLs or a total of three fail in any RGL row.

4 When a "caution" signal occurs, maintenance personnel manually reset the alarm using a dedicated contact closure as shown in Appendix 2, Figure 22. This allows the "caution" signal to be generated again if another non-critical failure occurs. A "fault" signal can only be cleared when the problem has been corrected. Note that a "caution" signal is always active when a "fault" signal is active.

(d) Mode of Operation for In-Pavement RGLs. An entire row of in-pavement RGLs should pulse in such a manner that the even-numbered lights in the row pulse simultaneously, and as they extinguish, the odd-numbered lights pulse simultaneously. Power should be applied alternately to each set of fixtures for 50 percent ± 0.5 percent, of the total cycle. Each fixture should pulse at a rate of 30-32 flashes per minute over all brightness settings.

(e) Failure Modes of In-Pavement RGLs. In the event of a lamp failure, the remaining lights in the RGL row should continue to pulse normally. In the event of a control system communications failure, the lights should continue to pulse in the normal sequence. Eight hours following a communications failure, the lights within each of the even and odd sets should pulse simultaneously, within a tolerance of 0.05 seconds. Further, the even set should pulse exactly opposite to the odd set, within a tolerance of 0.13 seconds. A failure of a local control device (component failure) should cause the associated lamp(s) to fail "off."

h. Stop Bar System.

(1) General. There are two types of stop bars: controlled and uncontrolled. Controlled stop bars are controlled individually via L-82 1 stop bar control panel(s) in the airport traffic control tower (ATCT). Uncontrolled stop bars are generally "on" for the duration of operations below 1,200 ft (365 m) RVR. If the need arises for an uncontrolled stop bar to be turned off, all stop bars for a given low visibility runway may be temporarily turned off via a master stop bar button for each low visibility runway.

(2) Power Supply. Elevated and in-pavement stop bar light circuits should be powered from an appropriately sized L-828, Class 1, Style 1 (3-step) constant current regulator. Brightness control is achieved by varying the output current of the constant current regulator. Elevated

stop bar fixtures should be installed on the same circuit as the associated in-pavement stop bar fixtures.

(3) Circuit Design.

(a) General. When the stop bar system is activated, all controlled and uncontrolled stop bars should be turned on at the same time and at the same intensity. Subsequent intensity changes should also occur in unison. It is not required to install all stop bars for a given runway on a dedicated circuit, although that is the simplest method of meeting the foregoing requirement.

(b) Controlled Stop Bars. Controlled stop bars operate in conjunction with taxiway centerline "lead on" lights, which are grouped into two segments as shown in Appendix 2, Figures 4a - 4d. Segment #1 begins at the stop bar and is 155 to 165 ft (47 to 50 m) long. Segment #2 consists of the remainder of the "lead on" lights to the point of tangency (PT) at the runway centerline if the total distance from the stop bar to the PT (measured along the curve) is less than 300 ft (90 m). If the total length exceeds 300 ft (90 m), segment #2 may consist of all "lead on" lights between the end of segment # 1 and the PT at the runway centerline, or segment #2 may be such that the total length of segment #1 and segment #2 is at least 300 feet (90 m) long.

Two stop bar sensors are used to automatically re-illuminate the stop bar and extinguish the "lead on" lights. Sensor #1 is located approximately at the end of "lead on" segment #1 . Sensor #2 is located approximately at the end of "lead on" segment #2. There are many different types of sensors which can be used to control stop bars and their exact location will depend on the type of sensor used. Sensors for stop bar control should be in accordance with AC 150/5000-l 3.

(c) Normal Operation of Controlled Stop Bars.

1 When air traffic control (ATC) issues a clearance to the pilot to enter the nmway, the controller depresses the stop bar button on the L-821 stop bar control panel. This action causes two backup timers to start, the red stop bar to be extinguished, and both segments of "lead on" lights to illuminate. The first timer (approximately 45 seconds) provides a backup to the first sensor. The second timer (approximately 2 minutes) provides a backup to the second sensor. In the event of a failure of either sensor, the backup timers will perform the same function as the respective sensor.

2 When the aircraft or vehicle activates sensor #1, the stop bar is re-illuminated and "lead on" segment #1 is extinguished. This protects the runway against inadvertent entry by a trailing aircraft or vehicle.

3 When the aircraft or vehicle activates sensor #2, "lead on" segment #2 is extinguished. If sensor #1 has failed and the backup timer for sensor #1 has not ended by the time sensor #2 is activated, then both segments of "lead on" lights should be extinguished and the stop bar should be re-illuminated.

(d) Special Operation of Controlled Stop Bars. From time-to-time, there is a need for multiple vehicles (i.e., airport rescue and fire fighting equipment and snow removal equipment) to be simultaneously cleared onto or across a runway at a location where a controlled stop bar is installed. In that event, the controller would depress the stop bar button while depressing the "Sensor Override" button on the control panel. (See AC 150/5345-3 for information on the control panel.) The control system should be designed so that the foregoing sequence of events will cause inputs from both sensors to be ignored. The stop bar and "lead on" lights should be reset to their original state when the backup timer for sensor #2 runs out.

(e) Failure Modes of Stop Bar Lights. In the event of a lamp failure, the remaining lights in the stop bar should continue to operate normally. The failure of a local control device (component failure) should cause any connected lamps to fail off. In the event of a control system failure (inclusive of a communication failure), the failure mode of the local control devices should be selectable depending upon visibility. An entire stop bar should fail on (individual lights fail off) for visibilities below 1,200 ft (365 m) RVR. The entire stop bar and individual lights should fail off for visibilities above 1,200 ft (365 m) RVR. Selection of the failure mode should be achieved remotely. Following the occurrence of a communications failure, a method should be provided to allow a failed stop bar to be turned off. This may be accomplished through various means, including turning off the power to an individual stop bar through an L-847 circuit selector switch, manually changing the failure mode of the local control devices, or having an integral timer within each local control device which automatically shuts off the lights 10 minutes, ±5 seconds, after the failure.

NOTE: The indication, on the stop bar control panel, of a failed controlled stop bar should continue to be displayed until the stop bar is returned to service.

(4) Stop Bar Control Methods.

(a) General. The two control methods described in Paragraph 8g(2)(c) for the control of in-pavement RGLs may also be used for the control of controlled stop bars and "lead on" lights. However, when multiple lights are installed on each local control device, every second, third, or fourth light may be installed on the same local control device.

(b) Control and Monitoring System Response Time. Within 2 seconds from the time the stop bar button in the ATCT is activated, the stop bar lights should be switched off and "lead on" lights switched on.

(5) Monitoring Requirements for Controlled Stop Bars. Controlled stop bars and associated "lead on" lights should be electronically monitored. Within 5 seconds of pressing the stop bar button, the actual status of the lights should be displayed on the stop bar control panel in the ATCT. This response time reflects the state-of-the-art for local control devices. Ideally, the lights would be switched and actual status returned to the ATCT within 2 seconds of pressing the stop bar button. It is recommended that the monitoring system has the capability of determining the number of lights that are not functional and whether or not the failed lights are adjacent. A standard L-827 monitor or L-829 constant current regulator with integral monitor may be used if it is accurately calibrated to indicate a fault indication with approximately 2 stop bar or "lead on" lights not functioning. Because this monitoring system is not capable of determining adjacency, a visual inspection would have to be made to determine whether or not the failed lights are adjacent.

NOTE: In locations where the circuit resistance to ground varies widely from day-to-day, it may not be possible to use the L-827 monitor for this level of precision.

i. Combination In-Pavement Stop Bar and Runway Guard Lights.

(1) Power Supply. Combination in-pavement stop bar/runway guard light fixtures have two lights, one red and one yellow, which are independently controlled. The power supply for the yellow light is as described in Paragraph 8g(1). The power supply for the red light is as described in Paragraph 8h(1).

(2) Circuit Design.

(a) Mode of Operation. The yellow lights should be operated down to, but not below, 1,200 ft (365 m) RVR. The red lightsshould be operated below 1,200 ft RVR, and not above.

NOTE: The yellow lights should not be temporarily turned on during the "GO" Configuration depicted in Appendix 2, Figure 4b.

(b) Failure Modes of Combination Stop Bars/RGLs . In the event of a lamp failure, the remaining lights in the stop bar or RGL row should continue to operate normally. In the event of a control system communications failure, the failure mode of the local control device should be selectable depending upon visibility. For visibilities below 1,200 ft (365 m) RVR, the yellow lights should fail off and the red lights should fail on. For visibilities above 1,200 ft (365 m) RVR, the yellow lights should pulse normally and the red lights should fail off. Selection of the failure mode should be achieved remotely. Following the occurrence of a communications failure, the failure mode should be selectable locally. The failure of a local control device (component failure) should cause both lights to fail off.

(3) Control Methods. Control methods for the yellow light is as described in Paragraph 8g(2)(c). Control methods for the red light is as described in Paragraph 8h(4).

(4) Monitoring. Monitoring requirements for the yellow light is as described in Paragraph 8g(2)(c). Monitoring requirements for the red light is as described in Paragraph 8h(5).

9. EQUIPMENT AND MATERIAL.

a. General. Equipment and material used in a taxiway centerline lighting system listed below conform to the AC and specification specified. All pertinent ACs and specifications are referenced by number and title in "Bibliography," Appendix 1.

Equipment and Material Used for Low Visibility Lighting Systems

Equipment and Material	Advisory Circulars or Items
L-82 1 'Remote Control Panel	AC 150/5345-3
L-847 Circuit Selector Switch	AC 150/5345-5
L-824 No. 8 AWG Cable	AC 150/5345-7
L-824 No. 10 AWG THWN Cable	AC 150/5345-7
L-824 No. 12 AWG Cable	AC 150/5345-7
L-828 Regulator	AC 150/5345-10
L-84 1 Auxiliary Relay Cabinet Assembly	AC 150/5345-13
L-823 Connectors	AC 150/5345-26
L-853 Retroreflective Markers	AC 150/5345-39
L-867 and L-868 Bases and L-869 Junction Box	AC 150/5345-42
L-804, L-852, and L-862S Light Fixtures	AC 150/5345-46

Eauiument and Material Used for Low Visibility Lighting Systems (continued)

Eauinment and Material	Advisory Circulars or Items
L-830 Isolation Transformer	AC 150/5345-47
L-854 Radio Control Equipment	AC 150/5345-49
Counterpoise Cable	*Item L-108 *Item L- 109
Conduit and Duct	*Item L-l 10
Joint Sealer, Type III	*P-605 (See Paragraph 6h)
Sealer Material (Liquid and Paste)	*P-606 (See Paragraph 6h)
Concrete Backfill	*P-610

* These items are referenced *in* AC **150/5370-10,** ***Standards for Specifying Construction of*** Airports.

b. **Vault.** The vault should be of the type shown on the design plans. Construction should be reinforced concrete, concrete masonry, brick wall, or prefabricated steel, as specified. Use distribution transformers, oil switches, cutouts, and all regularly used commercial items of equipment not covered by FAA specifications which conform to the applicable standards of the electrical industry.

c. Light Base and Transformer Housing. Use a base and transformer housing conforming to AC 150/5345-42, ***Specification for Airport Light Bases, Transformer Houses, Junction Boxes and*** Accessories. If the secondary wires are fed to the in-pavement lights through a saw kerf, a one-inch. hub should be welded to the base at 90 degrees from the two existing two-inch hubs which are 180 degrees apart. A gasket and suitable cover are also required for off-taxiway installation. Local conditions may require other modifications to the bases.

d. Retroreflective Markers. Use retroreflective markers conforming to AC 150/5345-39, ***FAA Specification L-853, Runway and Taxiway Centerline Retroreflective Markers.***

e. Preinsulated Connectors. When splicing the fixture leads to the No. 10 AWG THWN wires, use preinsulated connectors suitable for installation in the wireways.

f. Auxiliary Relays. Where required, use a hermetically sealed relay having a single pole double throw (SPDT) contact arrangement rated for 5 amperes at 120 volts AC and a coil resistance of 5000 ohms in a 120-volt AC control circuit. Relay connections may be either solder terminals or plug-in.

g. Optional Sealer Material. Other types of sealer material that provide satisfactory adhesive and waterproofing qualities may be used in lieu of sealer materials P-605 and P-606, upon approval of the engineer in charge. Sealer to be used in asphalt must be compatible with asphalt.

10. INSTALLATION.

a. General. This section recommends installation methods and techniques. Other methods and techniques, and variations of those outlined here, may be used; provided they are approved by the appropriate FAA Airports District Office (ADO). Correct placement of the lights is of prime importance; to achieve this, careful attention to detail is required. The light beam must be aligned as described in the lighting system design within a tolerance of ±1 degree. The lighting fixture must be level ±1/2 degree, and the top of the fixture edge must be between +0 inch (0 mm) and -1/16 inch (-1.5 mm) from the pavement top. To achieve this result, the light base, whether in one piece or in sections, must be aligned and held in place with jigs until finally secured. This method of installation requires surveying that is precise. The installation must be made with utmost care to avoid very costly remedial action.

b. Installation of Base-Mounted Fixtures and Conduit System.

(1) New Rigid Pavement. This system is preferred but requires careful attention to detail during installation. One of two conditions will be encountered during installation: the edge of existing pavement will be available as a reference for the new bases, or an existing edge will not be available and the bases must be set "in space." The availability of an existing pavement edge simplifies the task of locating the light base. In both cases, a jig or fixture is required to hold the base in position while the concrete anchor is placed. Azimuth and the elevation of the base with respect to the pavement surface are two parameters that must be met. It is absolutely necessary that the elevation of the flange be at least 3/4 inch (19 mm) below the pavement finished surface. If less than 3/4 inch (19 mm) is left after paving, the light fixture will be unacceptably high. If more than 3/4 inch (19 mm) is left, spacer rings can be used to bring the light fixtures up to the correct elevation. Allow for paving tolerances of ± 1/2 inch (13 mm) when setting the elevation of the fixture. At each light location, make an excavation in the pavement base which is large enough to accommodate the L-868 light base, the reinforcing steel cage, and concrete for the anchor. After the excavation is completed, the light base and reinforcing steel cage are installed and held in place with the jig. See Appendix 2, Figure 23. The jig will establish the elevation and azimuth of the base and maintain this position until the concrete anchor is placed. A recommended practice is to connect each base to the conduit system with a length of liquid-tight flexible conduit as in Appendix 2, Figure 24. Flexible conduit will allow adjustments in light base alignment before the concrete anchor is placed. Care must be taken while placing the concrete anchor that neither the jig nor the light base alignment is disturbed. The jig must remain in place until the concrete has set. During paving operations the light base may be fitted with a steel cover (mudplate). See Appendix 2, Figure 23. After the paving train has cleared the light base, remove excess concrete from the top of the base, and the edge of the opening around the base should be finished to a smooth radius. The surface of the pavement around the light base must be level with the surrounding pavement; dished and mounded areas are not acceptable. After the pavement has hardened, check the elevation of the top flange in relation to the finished surface. It may be necessary to install a flange ring, or flange and spacer ring, to bring the light fixture to correct elevation. Next, install primary cable, transformers, and connectors. Connect light fixture to secondary cable. Install an "O" ring gasket and torque holddown bolts to manufacturer's recommendations. If the paving technique utilizes more than one "pass" of the paving machine, the above procedure is altered as follows; a sectional light base is required and, after the bottom section has been installed as described above, the first pass is completed. The flange is then cleaned and the next section is installed with a sealant equal to RTV- 118, as manufactured by General Electric Company, between flanges, and torqued in place. The paving proceeds, and the fixture is installed as above. Base and conduit systems are subject to water intrusion. Consider base elevations, base heights, conduit slopes, drain holes, and other provisions to facilitate removal of water from the base and conduit system.

(2) New Flexible Pavement. A sectional base is required for flexible pavement. The bottom section of the light base (including concrete anchor) and the conduit system are installed in the pavement base as described in the preceding paragraph.

NOTE: Because of the loads placed on the cover plate during paving, a plywood cover should be a minimum of 5/8-inch (16 mm) thick. If the top section will not be installed right away, a mudplate (1/8 inch (3 mm) galvanized steel cover) should be used. It is then paved over. The light base, concrete anchor, and conduit backfill must not be higher than the base surface. After the paving is completed, a 2-inch (50 mm) hole is bored to accurately locate the center punch mark of the bottom section cover plate. This hole is used to measure the actual distance from the pavement surface to the top of the cover or mudplate. A top section should be obtained, who's height will accommodate the fixture and flange ring, and spacer ring if necessary. When the top section is received, a hole 1 inch (25 mm) larger than the diameter of the fixture should be drilled and the top section, flange ring, light fixture, and any spacer rings installed as described above. The space between the walls of the hole up to the top of the top section should be filled with liquid P-606 sealant which is compatible with asphalt. After the P-606 has cured, the remaining space should be filled with P-605, Type III sealant (which is compatible with asphalt) up to the top of the mud dam, if installed, or otherwise up to the top of the flange ring. See Appendix 2, Figure 25.

(3) Flexible Overlay. The installation of a light base and conduit system in a pavement to be overlaid is similar to that of a new flexible pavement installation, except the bottom section of the light base and the conduit are set in openings made in the existing pavement. The required concrete anchor and encasement of the conduit will be similar to that described in paragraph 10b(2). The use of a short length of liquid-tight flexible conduit is necessary to allow proper alignment. The remainder of the installation is as described in the preceding paragraph.

(4) Rigid Overlay. The installation of a light base and conduit system requires a combination of techniques outlined in paragraphs 10b(1) and 10b(3). The base and conduit are installed as in paragraph 10b(3); concrete is placed as in paragraph 10b(1).

c. Installation of Direct-Mounted Fixtures. While the installation of direct-mounted fixtures is becoming less common, there are instances where they are still applicable, e.g. overlays. However, they are not recommended for flexible pavement in very cold climates.

(1) Rigid Pavement. Drill holes or recesses in the pavement to accommodate the light fixtures. Saw wireways to accommodate electrical circuits. See Appendix 2, Figures 11, 26, and 27 for typical installation details.

(a) Pavement Drilling and Sawing,. Provide approximately 1/4-inch (6 mm) clearance for sealer material between the bottom and sides of the inset base receptacle and the recess. Provide extra depth where sawed wireways cross pavement joints. See Appendix 2, Figure 11 for detail.

1 Prior to placing the inset base receptacle in the drilled hole, clean all external surfaces to assure an adequate bond between fixture, sealer, and pavement. Sand blast if necessary. Avoid handling the fixtures by the leads.

2 Orient the fixture and arrange the leads properly with respect to their splicing position in the wireway. Use temporary dams, if required, for blocking the wireway entrance into the drilled hole. The dams will retain the sealer during the setting of the inset base receptacle. The orientation tolerance for the base is ±1 degree. Rugged, well-designed jigs are required to assure proper azimuth, elevation, and level.

3 Cover the bottom of the inset base receptacle with a paste-type adhesive material. Place a sufficient quantity of paste in the drilled hole. Place the base in the drilled hole to force adhesive up the sides of the base at least 1/8 inch (3 mm). Care must be taken to work out entrapped air. Use a liquid sealer (paragraph 9g) to fill the space between the base and the sides of the hole. Liquid sealer should be applied only between the inset base receptacle and the sides of the hole, and should not be applied between the sides of the hole and the top assembly.

(b) Wireways. Prior to the installation of the wires in the pavement, chamfer or round to 2-inch (50 mm) radius, the vertical edges of the wireways at intersections and comers. See Figure 11. Sandblast and clean wireways to insure proper bond between pavement material and the sealer. If wireways have been wet-sawed, flush these wireways with a high velocity stream of water immediately after sawing. Prior to installation of the sealer, the wireways must be dry and clean.

(c) Wires. Place the #10 AWG THWN wires in the wireways from the transformers near the taxiway edge to the light fixture leads. An adequate number of wedges, clips, or similar devices should be used to hold the wires in place at least 1/2 inch (13 m) below the pavement surface. The spacing between wedges, clips, etc., should not exceed 3 feet (900 mm). Wood wedges and plugs are not acceptable. Install the top of the wedges below the pavement surface. Splice the light fixture leads to the #10 AWG wires. Use pre-insulated connectors. Make the crimped splice with a tool that requires a complete crimp before releasing. Stagger the location of the splices. Permit no splices in the single conductor wires except at each fixture or L-869 junction box. If the installation is made in stages, tape or seal the ends of exposed wires to prevent the entrance of moisture. Seal the wires in the wireways with Item P-606 material. Apply in accordance with AC 150/5370-10 and the following steps:

1 Pour sealer in wireway until surface of wire is covered.

2 If recommended by the manufacturer, pour clean sand into the liquid sealer until a slight amount of sand shows on the surface. Use clean sand that can pass through a Number 40 sieve.

3 Fill the remainder of the wireway with liquid sealer to between 1/8 inch (3 mm) and 1/4 inch (6 mm) below the pavement surface.

(2) Flexible Pavement. Install direct-mounted light fixtures and wires in flexible pavement in a manner similar to the installation procedures for rigid pavements (paragraph 10c(1)) with the following precautions:

(a) Clean the holes and wireways immediately before installation so that the clean, dry aggregate of the pavement is exposed.

(b) Use sealant which is compatible with asphalt.

(c) Mix the P-606 sealant (for use on fixtures) so that it sets up within 15 minutes.

(d) Use sealant that conforms to P-606 to seal wires in wireways.

(e) Junction boxes may be installed on runways where overlays are anticipated. See Appendix 2, Figure 28. When additional pavement is required, the inset light is removed and the base is fitted with a cover. Paving is then applied over the light base and junction box. When the paving is completed, expose the junction box and light base by coring. Remove covers. Proceed as described in Paragraph 1 0b(2).

d. Vault.

(1) Install the airport vault and equipment in accordance with AC 150/5370-10, Item L-109.

(2) Exercise care while working in the vault to prevent drill deposits, iron filings, insulation stripping, or other foreign matter deposits from collecting on relays, switches, and other operating components. Collect and remove all residue as the installation progresses. Use covers or shields during installation and wiring to protect components from foreign matter.

e. Cable Installation.

(1) General. Although primary cables and control cables may be direct buried, it is preferable to install them in conduit in accordance with Item L-108.

(2) Primarv Cable Installation. Install primary cable in a trench from the regulator into a light base and transformer housing in the field. Provide slack cable in each light base and transformer housing to permit connections of the primary cable and the isolation transformer primary leads to be made above ground. Seal the cable entrance of the light base transformer housing with squeeze connectors, where specified. These squeeze connectors are provided with a rubber bushing of the correct size to fit the outside diameter of the cable. Tighten the squeeze connectors to provide a watertight seal without deforming the insulation and jacket of the cable. Tape the ends of cables to prevent the entry of moisture until connections are made. See Appendix 2, Figure 29, for trench detail and wire placement.

(3) Primarv Cable Connections. Make in-line splices on the primary underground cables to conform to Item L-108. Use connectors conforming to AC 150/5345-26, Specification *for* L-823 Plug and Receptacle, *Cable Connectors.* Splices in ducts, conduits, or in the primary cables between light base and transformer housings are not allowed. When field attached plug-in connectors are employed, use a crimping tool designed for the specific type connector to assure that crimps or indents meet the necessary tensile strength. Wrap the connector joints in the primary circuit with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extended at least 1-1/2 inches (38 mm) on each side of the joint. "Heat shrink" material may be used.

(4) Secondary Lead Connections. Make connections to the secondary isolation transformer leads and the No. 10 AWG wires with a disconnecting plug and receptacle conforming to AC 150/5345-26. Attach the L-823, Class B, Type II, Style 4 plug on the end of the two No. 10 AWG wires using a crimping tool designed for this connector to assure a crimp or indent meets the necessary tensile strength. Insert this connector into the transformer secondary receptacle. See Appendix 2, Figures 26 and 27, for typical secondary wiring details.

f. Identification Numbers. Assign identification numbers to each station (transformer housing installation) in accordance with the plans. Place the numbers to identify the station by one of the following methods:

(1.) Stenciling. Stencil numbers of two-inch (50 mm) minimum height using black paint on the taxiway side of the transformer housing base plate.

(2) Metal Disc. Attach a noncorrosive disc of two-inch (50 mm) minimum diameter with numbers permanently stamped or cut out under the head of a transformer housing base plate bolt.

(3) Paint. Impress on a visible portion of the concrete backfill numbers of three-inch (75 mm) minimum height.

g. Duct and Cable Markers. Mark all locations of the ends of ducts and all direct earth burial cable with a concrete marker slab in accordance with Items L-108 and L-l 10. See Appendix 2, Figure 29, for duct and cable marker details.

11. TESTING AND INSPECTION.

a. General. Because certain components may be inaccessible after final installation, inspect and test taxiway centerline lighting concurrently with installation.

b. Secondary Circuits. Test the secondary circuit for each subsection for continuity and insulation resistance to ground before the wireways are filled with a sealant. Use a 500-volt (minimum) megger for the insulation resistance test. A circuit resistance of at least 50 megohms is acceptable.

c. Elevation. Check the light unit installation procedures during construction and after the system has been completed to determine that the recommended fixture elevation is in accordance with design and installation requirements.

d. Alignment. Check the light unit installation procedures during construction and the completed system to determine that the fixture alignment is in accordance with design and installation requirements. Make final adjustments at night and to the satisfaction of the engineer in charge.

e. Securing Screws or Bolts. Determine that all fixture securing screws or bolts have been tightened in accordance with the manufacturer's recommendations. Use an anti-seize compound on bolts made of 4 10 steel with a black coating. See AC 150/5345-46.

f. Light Channels and Lenses. Visually check each light fixture to determine that the lenses and the channels in front of the lenses are clean.

g. Primary and Control Cables. Test the primary and control cables as specified under the applicable sections of Item L-108.

h. Operational.

(1) General. Before connecting and energizing the regulator, make a 24-hour recording of the primary input voltage to determine which regulator voltage tap to use. If'the maximum input voltage exceeds the 480-volt maximum tap, correct the input voltage. Install lamps in all light fixtures for check out. Operations with excessive open isolation transformer loads can damage a monocyclic type resonant circuit regulator.

(2) Open-Circuit Protection. Check the open-circuit protective device only once, then allow a five-minute cooling period before rechecking. Continuous cycling of the protective device can overheat and bum out the thermal relay.

(3) Complete System Operation. Test the installation by continuous operation for not less than one-half hour as a complete system including the functioning of each control not less than ten times. Test the completed circuits in accordance with the applicable provisions of Item L-108.

(4) Equipment. Check equipment covered by FAA specifications to determine if the manufacturers are certified under AC 150/5345-53, *Airport Lighting Equipment Certification Program.* Check the equipment for conformance with specification requirements.

(5) Transformer and Feeder Fusing. Check to determine that the primary (high voltage) fuses for transformers and feeders do not exceed 200 percent of the rating of the transformer. Secondary (low voltage) fuses for transformers and feeders should not exceed 125 percent of the transformer rating.

(6) Vault Equipment. Test the vault equipment as specified in Item L-109. Include a check to determine that the resistance to ground of any part of the grounding system will not exceed 10 ohms.

(7) Equipment. Subject all regulators and other applicable equipment to performance tests specified in the manufacturer's instructions.

(8) Cables, Wiring and Splices. Check all cables, wiring, and splices to obtain assurance that the installation is in accordance with Item L-108. Check underground cables and wire in saw kerfs before the installation is completed.

(9) Ducts and Duct Markers. Assure that all ducts and duct markers are installed in accordance with Item L- 110. Check underground ducts before installation is completed.

12. MAINTENANCE.

a. General. A maintenance program is necessary at airports with low visibility taxiway lighting systems to insure proper operation and dependable service from the equipment. The taxiway lighting systems may be of the highest order of reliability, but their effectiveness will soon decline unless they are properly maintained.

(1) Schedule. Adopt a systematic maintenance schedule to ensure maximum efficiency by detecting faults and avoiding deterioration of the system. The lighting system can become ineffective if maintenance is not performed.

(2) Proper Maintenance. Proper maintenance consists of a regular schedule of testing, cleaning, adjusting, repairing, and replacing worn-out or damaged parts. Dirty equipment contributes greatly to operation failure; therefore, keep all equipment free of dust, sand, surplus grease and oil, and other foreign material. Replace all lamps and broken glassware. Periodically clean the lens reflector and light channel in front of the lens in accordance with manufacturer's recommendations. Weather and the location of the fixture will dictate the regularity and type of cleaning.

(3) Snow Removal. Recommended snow removal techniques are described in AC 150/5200-30, *Airport Winter Safety and Operations.* Snowplow operators must exercise extra care not to strike the lighting fixtures with snowplow blades. After snow removal operations, inspect all lighting fixtures to locate and replace, if necessary, all damaged light assemblies.

b. Operational Check and Test. Make a daily check of the lighting system and operation of equipment at least one hour before sunset, and in accordance with AC 120-57 when low visibility operations are likely. The daily check of the lighting system consists of a driving patrol to visually check for dimly burning lamps and burned out lamps which are recorded for later maintenance check and replacement. Assign the daily operational test of equipment to a reliable and competent person stationed at the airport during the evening hours who has been fully familiarized with the procedures. These procedures consist of turning on all airport lighting systems covered by this AC, except stop bars, to determine that each circuit is functioning normally. Proper functioning of the stop bars should be checked at a frequency which would ensure that they are operative when low visibility conditions occur. Notify the maintenance electrician immediately when a malfunction of any lighting circuit is noted.

c. Lamp Replacement. Notify tower personnel when lamp replacement is to begin. De-energize the constant current regulator supplying the primary series circuit to the taxiway centerline lighting system containing the burned out lamps in accordance with established safety standards and procedures. Refer to AC 150/5340-26, *Maintenance of Airport Visual Aid Facilities,* for additional information on safety procedures. Remove the light assembly or lamp assembly and replace the lamp. Replace the gaskets if they appear to be worn or damaged. Clean and dry out the assembly before replacing the light assembly or lamp assembly. Properly seal all gaskets. Tighten all screws, bolts, and other securing hardware with a torque wrench or screwdriver in accordance with manufacturer's recommended torque. Re-energize the primary circuit to the regulator in accordance with established safety standards and procedures. Notify tower personnel that maintenance work is completed and have them check the brightness setting from their remote station.

d. Removal of Water. Taxiway centerline lighting assemblies are designed to exclude both ground and surface water from entering critical areas. Where below-freezing temperatures are encountered, water left in the assembly can become a serious problem, Ice within the assembly can cause damage to the assembly by shearing the top assembly or lamp assembly holddown hardware or rupturing the top assembly or lamp assembly. A regular schedule for tightening screws, bolts, and other securing hardware should be adopted. Where water is noted, remove the water and clean and dry lenses, receptacle, lamp, and electrical contacts.

e. Cables. Automatic meggering systems are available, which safely and regularly perform resistance checks of airport lighting cables. If an automatic meggering system is not installed, manual meggering will be necessary.

Megger homeruns of cable with a 500-volt (minimum) megger after the installation has been accepted. Record and retain the megger readings. Make monthly readings and compare these readings with the initial values recorded to determine existing conditions of the system. The initial megohm resistance value in an acceptable system should not be less than 50 megohms. Take corrective steps promptly when monthly megger checks reveal progressive deterioration or faults. Open circuits and grounded circuits are the most common faults in series underground cable.

(1) Monthlv Meager Checks. Monthly megger checks are accomplished by first notifying tower personnel that maintenance work is to start. De-energize the regulator in accordance with established safety standards and procedures. Disconnect the series cutout (on the output of the regulator). Connect one lead of the megger to the series cable and the other lead of the megger to a proven ground. Operate the megger in accordance with established safety standards and procedures. Notify tower personnel when maintenance work has been completed. Check operation of the regulator by instructing the tower personnel to operate the regulator through all brightness settings from the remote control panel.

(2) Trouble Shooting Series Circuits. Only authorized personnel should be allowed to troubleshoot on series lighting circuits because of the high open circuit voltages encountered when the primary of a series circuit is open-circuited. Open circuit voltages as high as 2,270 volts may be encountered in a series circuit connected across a 7-1/2KW, 6.6-ampere regulator. Regulators having a higher KW capacity and the same current rating will have a greater open circuit voltage. Troubleshooting for taxiway centerline lighting systems is complicated by the fact that some of the interconnecting wires may be sealed in the taxiway pavements. It is important, for this reason, to check the system wiring during installation and to establish an effective preventive maintenance program.

f. Vault. Keep the vault clean and uncluttered to prevent dirt from accumulating in control compartments and to allow equipment to be accessible at all times. Mount legible warning signs in conspicuous locations.

APPENDIX 1. BIBLIOGRAPHY.

1. Copies of the following publications may be ordered from the Department of Transportation, General Services Division, M-45, Washington, DC 20590, Phone (202) 267-3 115, or downloaded from the Internet, if available. See Paragraph 9 on the cover of this AC for information on downloading.

a. AC 120-57, ***Surface Movement Guidance and Control System (SMGCS).***

b. AC 150/5000-13, ***Announcement of Availability--RTCA Inc., Document RTCA-221, Guidance and Recommended Requirements for Airport Surface Movement Sensors.***

c. AC 150/5200-30, ***Airport Winter Safety and Operations.***

d. AC 150/5300- 13, ***Airport Design.***

e. AC 150/5340-24, ***Runway and Taxiway Edge Lighting System.***

f. AC 150/5340-26, Maintenance ***of Au-port Visual Aid Facilities.***

g. AC 150/5345-3, ***Specification for L-821 Airport Lighting Panels for Remote Control of Airport Lighting.***

h. AC 150/5345-5, ***Circuit Selector Switch.***

i. AC 150/5345-7, ***Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits.***

j. AC 150/5345-10, ***Specification for Constant Current Regulators and Regulator Monitors.***

k. AC 150/5345-13, ***Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.***

l. AC 150/5345-26, ***Specification for L-823 Plug and Receptacle, Cable Connectors.***

m. AC 150/5345-39, ***FAA Specification L-853, Runway and Taxiway Retroreflective Markers.***

n. AC 150/5345-42, ***Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories.***

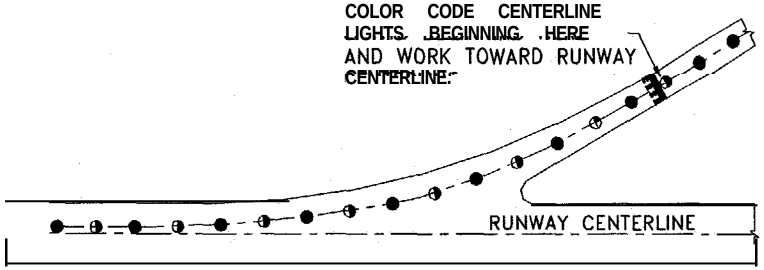
o. AC 150/5345-46, ***Specification for Runway and Taxiway Light Fixtures.***

p. AC 150/5345-47, ***Isolation Transformers for Airport Lighting Systems.***

q. AC 150/5345-49, ***Specification L-854, Radio Control Equipment.***

r. AC 150/5345-53, ***Airport Lighting Equipment Certification Program.***

2. To obtain copies of AC 150/5370-10, mail your request to: New Orders, Superintendent of Documents, P.O. Box 37 1954, Pittsburgh, PA 15250-7954. Refer to the document being requested as: SN 050-007-0082 1-O. Send check or money order with your request made payable to the Superintendent of Documents in the amount of $23.00 for each copy. No c.o.d. orders accepted. This AC may also be downloaded from the Airports Internet site at no cost.



NOTES

1. THE FIRST LIGHT ON THE RUNWAY IS GREEN. IF THERE IS AN ODD NUMBER OF COLOR-CODED LIGHTS, THE FIRST TWO LIGHTS SHOULD BE GREEN.

2. IF THERE IS AN ILS/MLS CRITICAL AREA PRESENT BEYOND THE RUNWAY HOLDING POSITION, THE COLOR-CODED LIGHTS CONTINUE TO THE ILS/MLS CRITICAL AREA HOLDING POSITION WITH THE LAST YELLOW LIGHT SIMILARLY LOCATED BEYOND THE CRITICAL AREA HOLDING POSITION.

3. SEE PARAGRAPH 8f (1) FOR INFORMATION ON FIXTURE SELECTION.

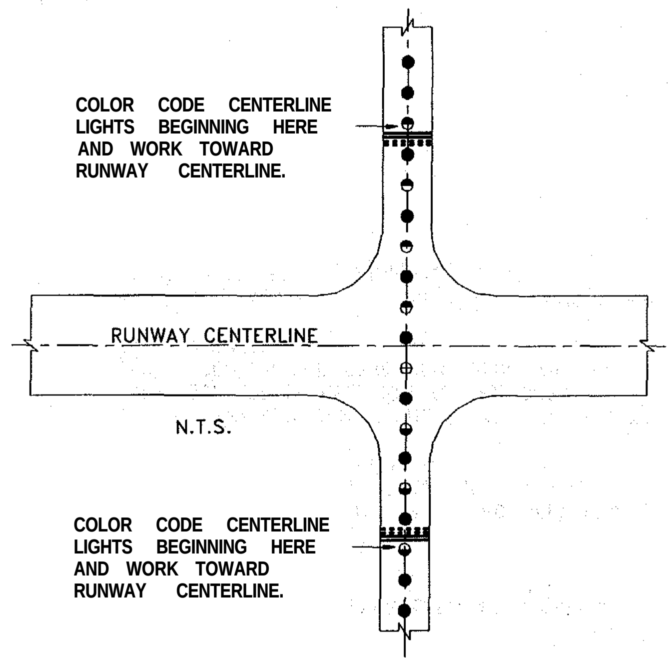
(A) EXIT TAXIWAY

LEGEND

Y ◑ G BIDIRECTIONAL YELLOW-GREEN

G ● G BIDIRECTIONAL GREEN-GREEN

Y ⦶ Y BIDIRECTIONAL YELLOW-YELLOW



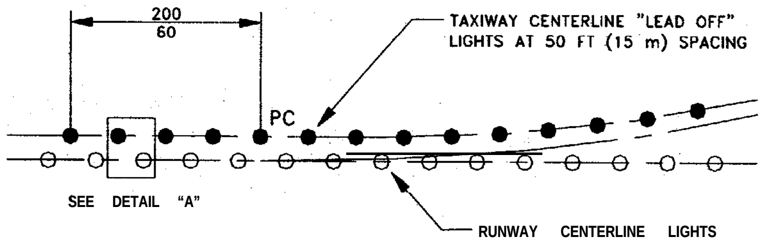
NOTES

1. THE LIGHTS ARE COLOR-CODED IN ACCORDANCE WITH PARAGRAPH 3.b. WHERE BIDIRECTIONAL LIGHTS ARE INSTALLED, EACH DIRECTION IS COLOR-CODED INDEPENDENTLY.

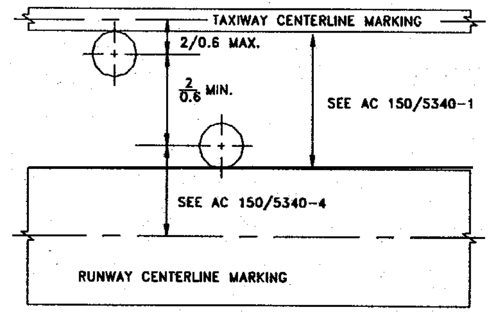
2. IF THERE IS AN ILS/MLS CRITICAL AREA PRESENT BEYOND THE RUNWAY HOLDING POSITION, THE COLOR-CODED LIGHTS CONTINUE TO THE ILS/MLS CRITICAL AREA HOLDING POSITION WITH THE LAST YELLOW LIGHT SIMILARLY LOCATED BEYOND THE CRITICAL AREA HOLDING POSITION.

(B) TAXIWAY CROSSING A RUNWAY

FIGURE 2. COLOR-CODING OF EXIT TAXIWAY CENTERLINE LIGHTS



LIGHT LOCATIONS AT BEGINNING OF ACUTE-ANGLED EXIT TAXIWAY



DETAIL "A"

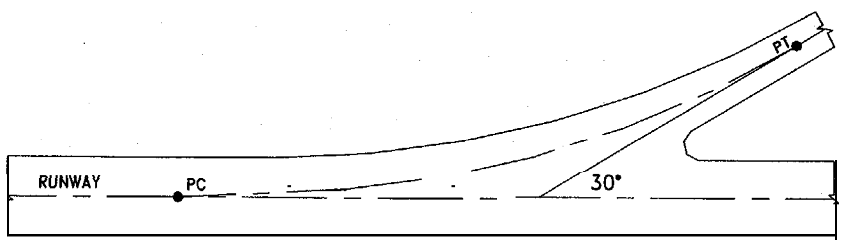
NOTES:

1. DIMENSIONS ARE EXPRESSED AS $\frac{\text{FEET}}{\text{METERS}}$ E.G. $\frac{200}{60}$

2. THE TAXIWAY CENTERLINE "LEAD OFF" LIGHTS MAY BE INSTALLED ON EITHER SIDE OF THE TAXIWAY CENTERLINE MARKING.

3. THE TAXIWAY CENTELRINE "LEAD OFF" LIGHTS ARE INSTALLED IN RELATION TO THE CURVE DESIGNATED AS THE TRUE CENTERLINE OF THE TAXIWAY PATH.

4. THE ORIENTATION OF THE LIGHT BEAMS SHALL BE AS SPECIFIED IN PARAGRAPH 31(4).



ACUTE-ANGLED EXIT TAXIWAY (TYPICAL)

FIGURE 3. TAXIWAY CENTERLINE LIGHTING CONFIGURATION FOR ACUTE-ANGLED EXITS

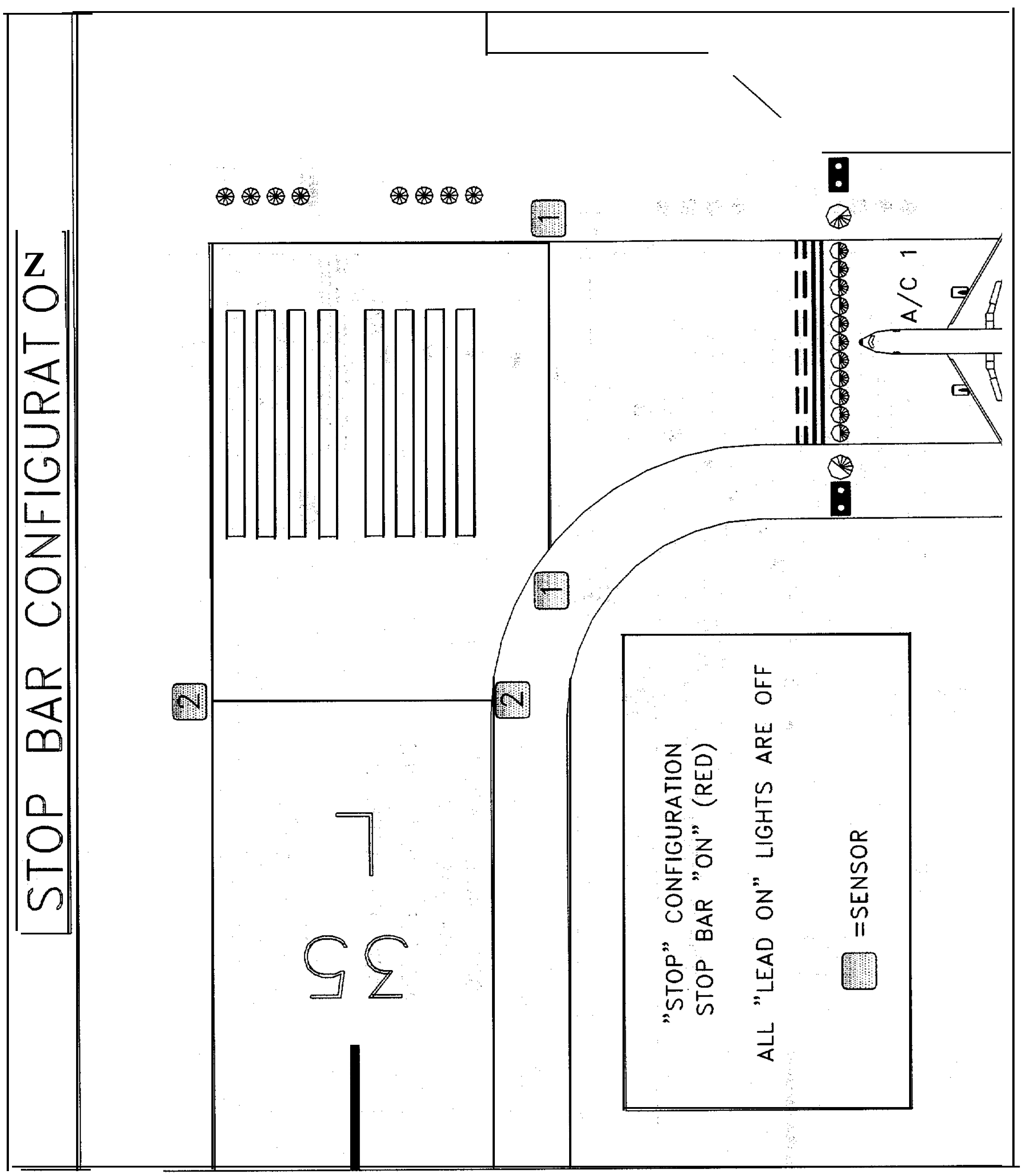


FIGURE 4a. CONTROLLED STOP BAR DESIGN AND OPERATION

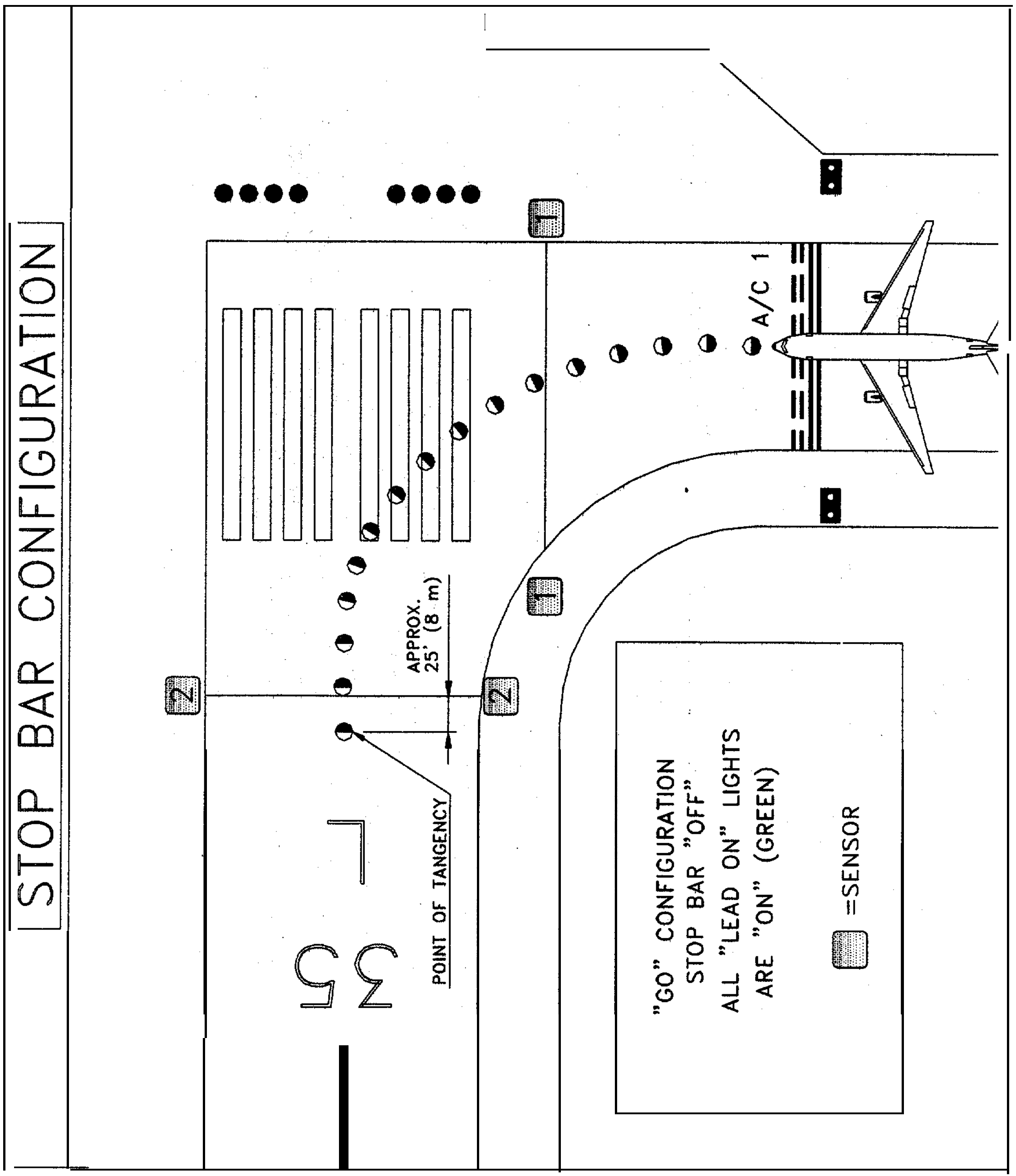
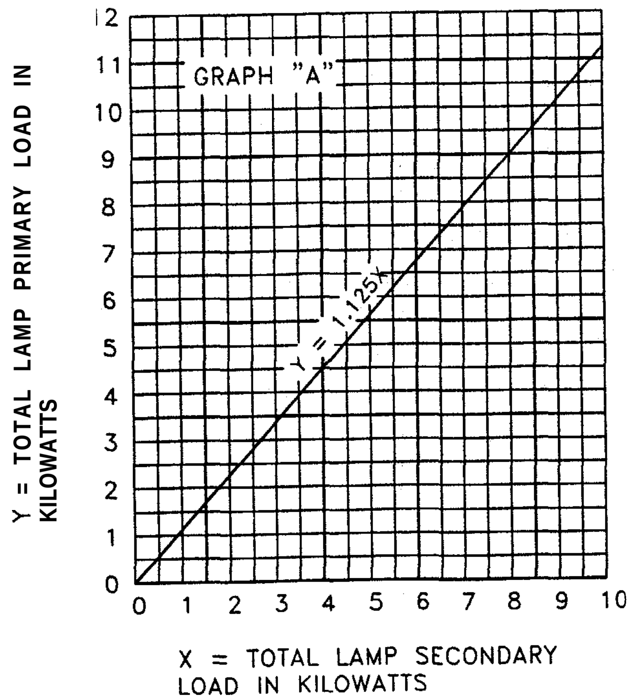
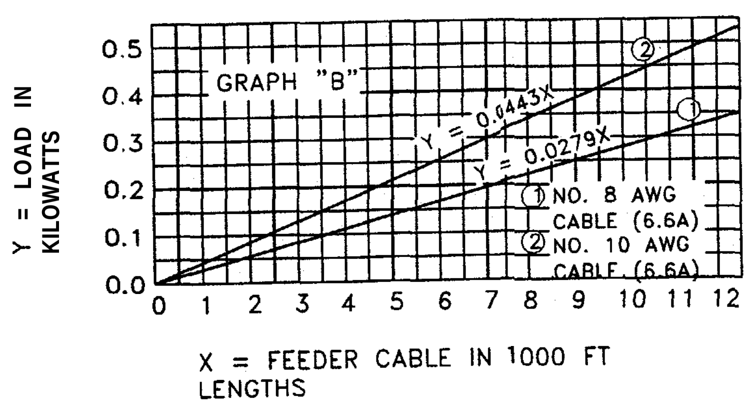
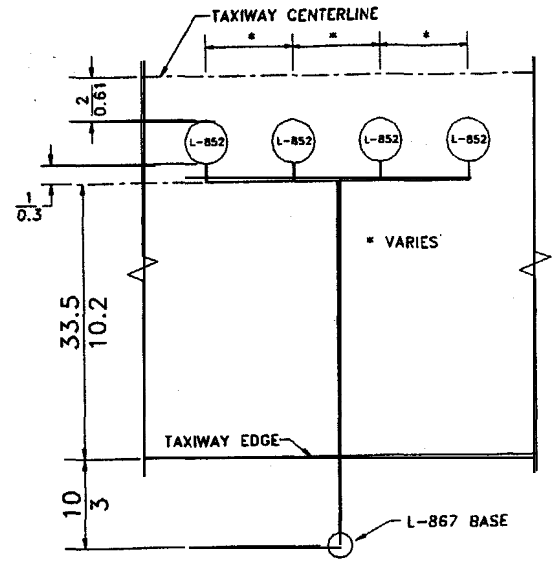


FIGURE 4b. CONTROLLED STOP BAR DESIGN AND OPERATION

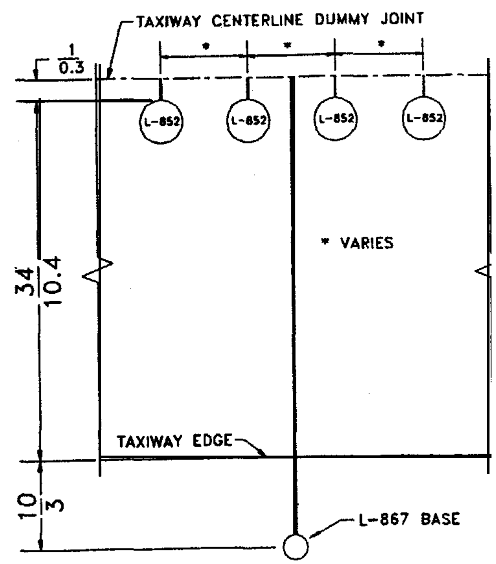




DIMENSIONS ARE EXPRESSED THUS: $\frac{\text{FEET}}{\text{METERS}}$ e.g. $\frac{10}{3}$



STATION "A" FLEXIBLE PAVEMENT



STATION "B" RIGID PAVEMENT

HOW

1. Assumption. A taxiway cen
station spaced longitudina
wide-beam fixtures and twe
distance of 2,500 feet.

a. Total Lamp Secondary W

10 stations x 4 lights,
12 stations x 4 lights,

b. Total Lamp Primary Wat

From Graph "A", 4,760

c. Total Number feet of 1

From the configuration
kerf, four vertical sa
foot longitudinal saw
(transformer housing).

300 foot longitudi
1 foot vertical sa
33.5 foot vertical
10 feet taxiway ed

Total number

695 feet Number 10

d. Total Number 10 AWG Ca

From Graph "B", 15,29

e. Total Number Feet Num

22 stations, as show
L-867 bases). Also,

21 spaces x 400 fe
2,500 feet (home-

Total number feet

f. Total Number 8 AWG Ca

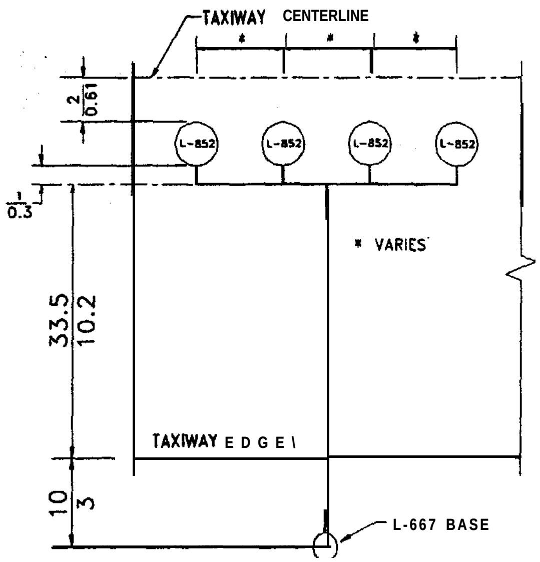
From Graph "B", 21,80

g. Total 6.6 Ampere Prim

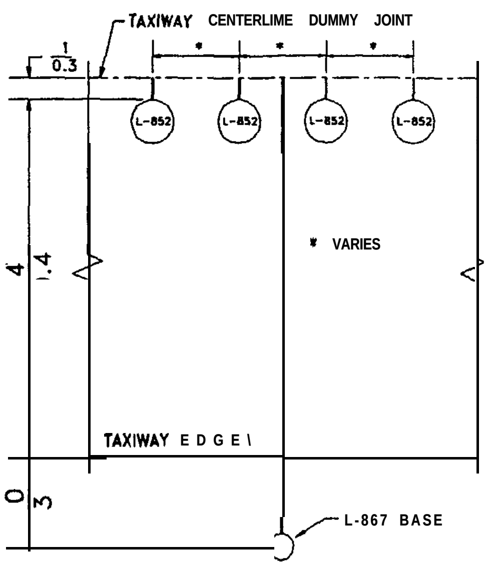
Add total KW loads ob

Paragraph b.
Paragraph d.
Paragraph f.

Total Primary KW load



STATION "A" FLEXIBLE PAVEMENT



STATION "B" RIGID PAVEMENT

HOW TO OBTAIN THE 6.6 AMPERE PRIMARY KW LOAD
SAMPLE CALCULATIONS

1. Assumption. A taxiway centerline lighting configuration composed of 22 stations of four lights per station spaced longitudinally at 100 feet as shown in Station "A" Flexible Pavement. Ten stations of 65W wide-beam fixtures and twelve stations of 45W narrow;-beam fixtures with a cable home-run separation distance of 2,500 feet.

a. Total Lamp Secondary Watts.

10 stations x 4 lights/station x 65 watts/fixture= 2,600 watts
12 stations x 4 lights/station x 45 watts/fixture= 2,160 watts

Total Lamp Secondary Watts = 4,760 watts

b. Total Lamp Primary Watts.

From Graph "A", 4,760 watts total lamp secondary load equals 5.355 KW total lamp primary load.

c. Total Number feet of 10 AWG Secondary Cable.

From the configuration shown in Station "A" Flexible Pavement, we have a 300 foot longitudinal saw kerf, four vertical saw kerfs of 1 foot, one vertical saw kerf edge of taxiway pavement to the 300 foot longitudinal saw kerf of 33.5 feet, and a distance of 10 feet from taxiway edge to the L-867 base (transformer housing).

300 foot longitudinal saw kerf x 2 (number of cables) =	600 feet
1 foot vertical saw kerf x 4 (number of saw kerfs) x 2 (number of cables) =	8 feet
33.5 foot vertical saw kerf x 1 (number of saw kerfs) x 2 (number of cables) =	67 feet
10 feet taxiway edge to L-967 base x 1 (number of runs) x 2 (number of cables) =	20 feet
Total number of feet of Number 10 AWG cable used per station =	695 feet

695 feet Number 10 AWG cable per station x 22 stations = 15,290 feet total secondary cable.

d. Total Number 10 AWG Cable Primary KW Load.

From Graph "B", 15,290 feet of Number 10 AWG secondary cable equals 0.677 KW primary load.

e. Total Number Feet Number 8 AWG Primary Cable.

22 stations, as show in Station "A" Flexible Pavement, has 21 spaces of 400 feet (separation between L-867 bases). Also, we have 2,500 feet home-run separation.

21 spaces x 400 feet separation x 2 (number of cables) = 16,800 feet
2,500 feet (home-run separation) x 2 (number of cables) = 5,000 feet

Total number feet of Number 8 AWG primary cable = 21,800 feet

f. Total Number 8 AWG Cable Primary KW Load.

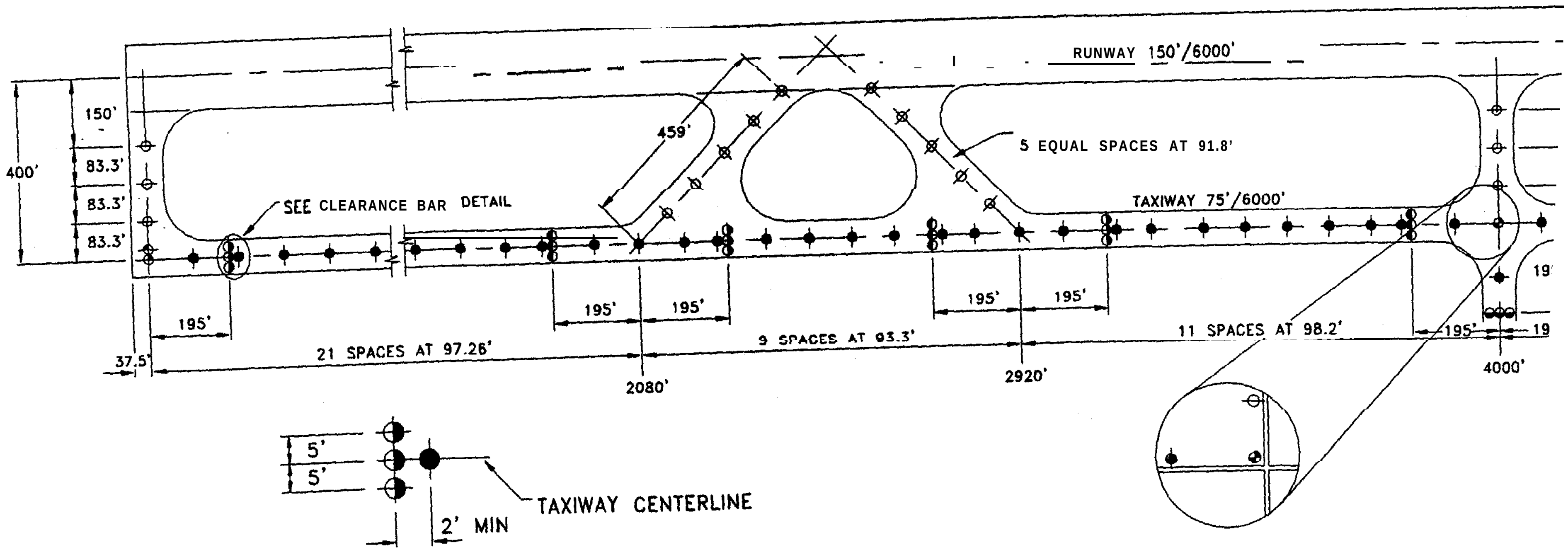
From Graph "B", 21,800 feet Number 8 AWG primary cable equals 0.608 KW primary load.

g. Total 6.6 Ampere Primary KW Load.

Add total KW loads obtained in paragraphs b, d, and f above.

Paragraph b. = 5.355 KW
Paragraph d. = 0.677 KW
Paragraph f. = 0.608 XW

Total Primary KW load = 6.640 KW



CLEARANCE BAR DETAIL

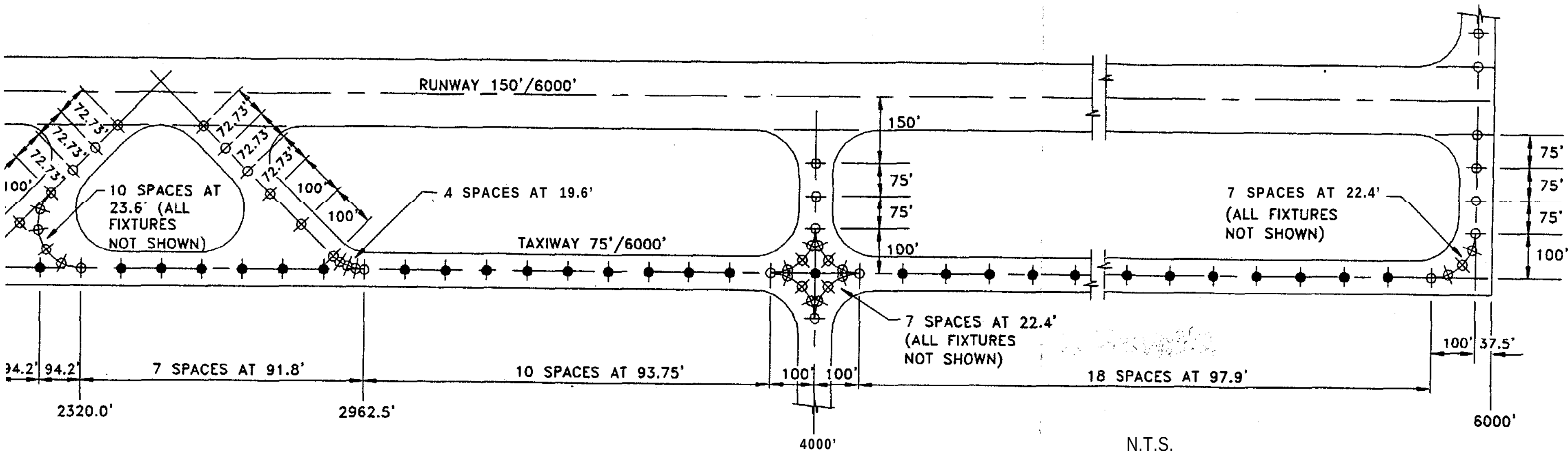
LEGEND

G⊕G	L-8528	BIDIRECTIONAL	GREEN-GREEN
B◐Y	L-852A	UNIDIRECTIONAL	BLANK-YELLOW
B⊕G	L-852B	UNIDIRECTIONAL	BLANK-GREEN
G●G	L-852A	BIDIRECTIONAL	GREEN-GREEN
Y	L-852E	OMNIDIRECTIONAL	YELLOW

NOTES

1. SEE PARAGRAPH 7A FOR INFORMATION ON CLEARANC
2. CLEARANCE BARS ON EXIT TAXIWAYS MAY BE OMITT
3. CLEARANCE BARS ARE LOCATED IN RELATION TO TH DESIGNED. THEY ARE INSTALLED 2 FEET FURTHER FROI AC 150/5340-1, FOR TAXIWAY INTERSECTION MARKING:
4. THE METRIC EQUIVALENT (IN METERS) MAY BE FOU

FIGURE 1. TYPICAL TAXIWAY CENTERLINE LIGHTING CONFIGURATION FOR NON-!
(Centerline light spacing for operations above 1,200 feet (365 tn) RVR)



NOTES

1. RUNWAY AND TAXIWAY FILLETS ARE IN ACCORDANCE WITH AC 150/5300-13.

2. LONGITUDINAL SPACING OF LIGHTS SPECIFIED IN PARAGRAPH 3C OF THIS CIRCULAR WAS ADHERED TO AS CLOSELY AS POSSIBLE.

3. ORIENTATION OF THE LIGHT BEAMS SHOULD BE AS SPECIFIED IN PARAGRAPHS 3l(1) AND 3l(2).

4. THE METRIC EQUIVALENT (IN METERS) MAY BE FOUND BY DIVIDING FEET BY 3.281.

AL TAXIWAY CENTERLINE LIGHTING CONFIGURATION FOR STANDARD FILLETS
line light spacing for operations above 1,200 feet (365 m) RVR)

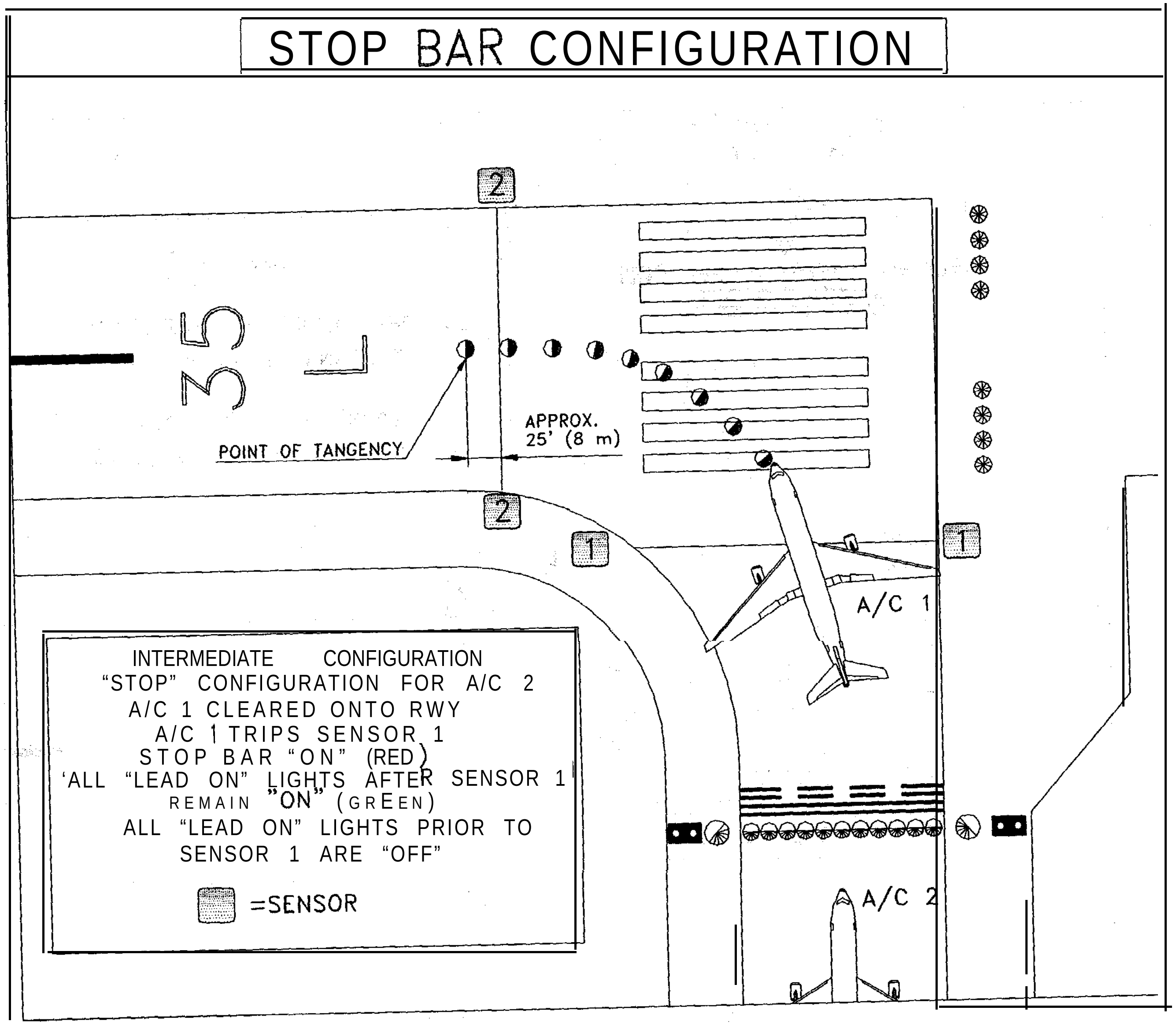


FIGURE 4c. CONTROLLED STOP BAR DESIGN AND OPERATION

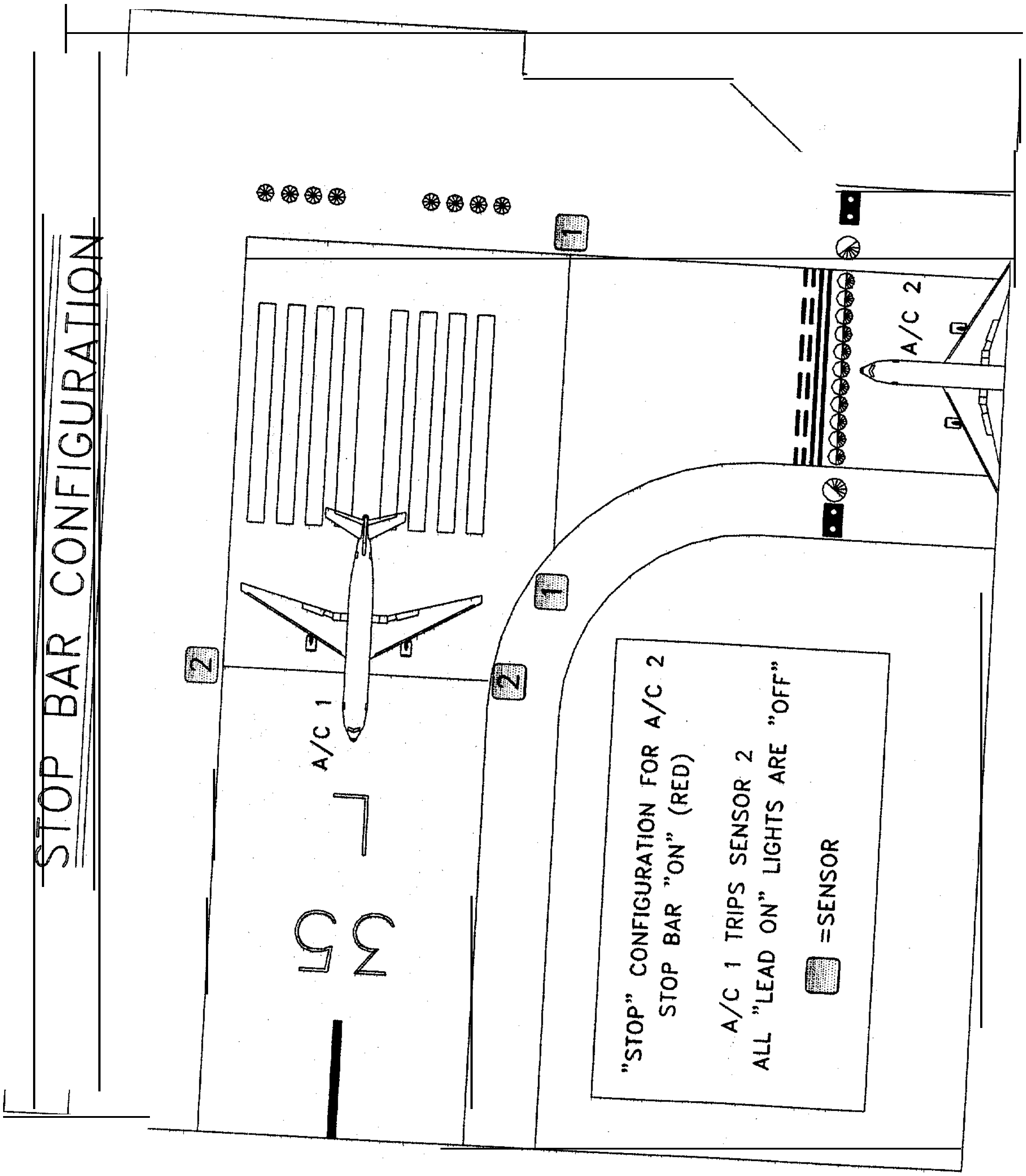
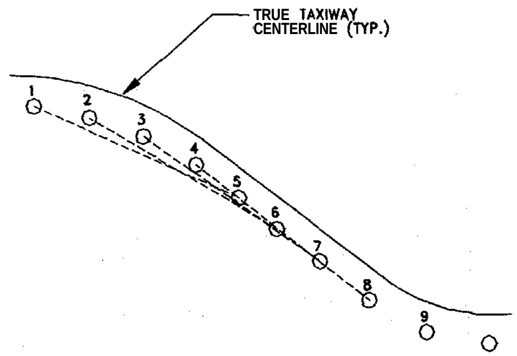
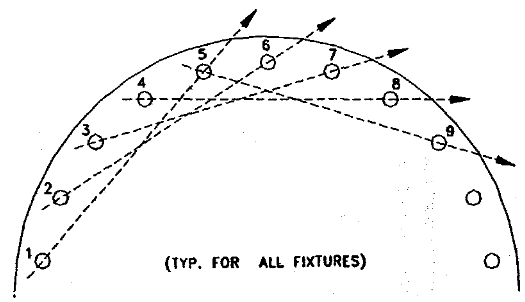


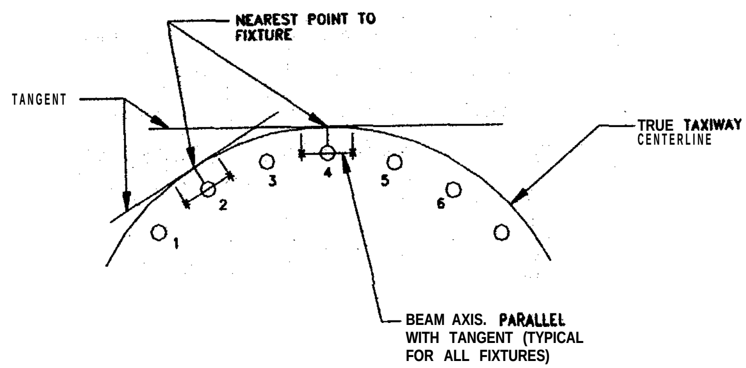
FIGURE 4d. CONTROLLED STOP BAR DESIGN AND OPERATION



UNIDIRECTIONAL LIGHT ON SPIRAL CURVE



UNIDIRECTIONAL LIGHT ON CIRCULAR CURVE



BIDIRECTIONAL LIGHT ON CIRCULAR CURVE

NOTES:

1. FOR BIDIRECTIONAL LIGHTS, THE AXIS OF THE TWO BEAMS SHALL BE ORIENTED PARALLEL TO THE TANGENT OF THE NEAREST POINT OF THE CURVE DESIGNATED AS THE TRUE CENTERLINE OF THE TAXING PATH.
2. FOR UNIDIRECTIONAL LIGHTS, THE AXIS OF THE BEAM SHALL BE "TOED IN" TO INTERSECT THE CENTERLINE AT A POINT APPROXIMATELY EQUAL TO FOUR TIMES THE SPACING OF LIGHTS (EVERY FOURTH LIGHT) ON THE CURVE. PORTION. AND SUCH SPACING SHALL BE MEASURED ALONG THE CHORD OF THE CURVE.

FIGURE 6. TAXIWAY CENTERLINE LIGHT BEAM ORIENTATION

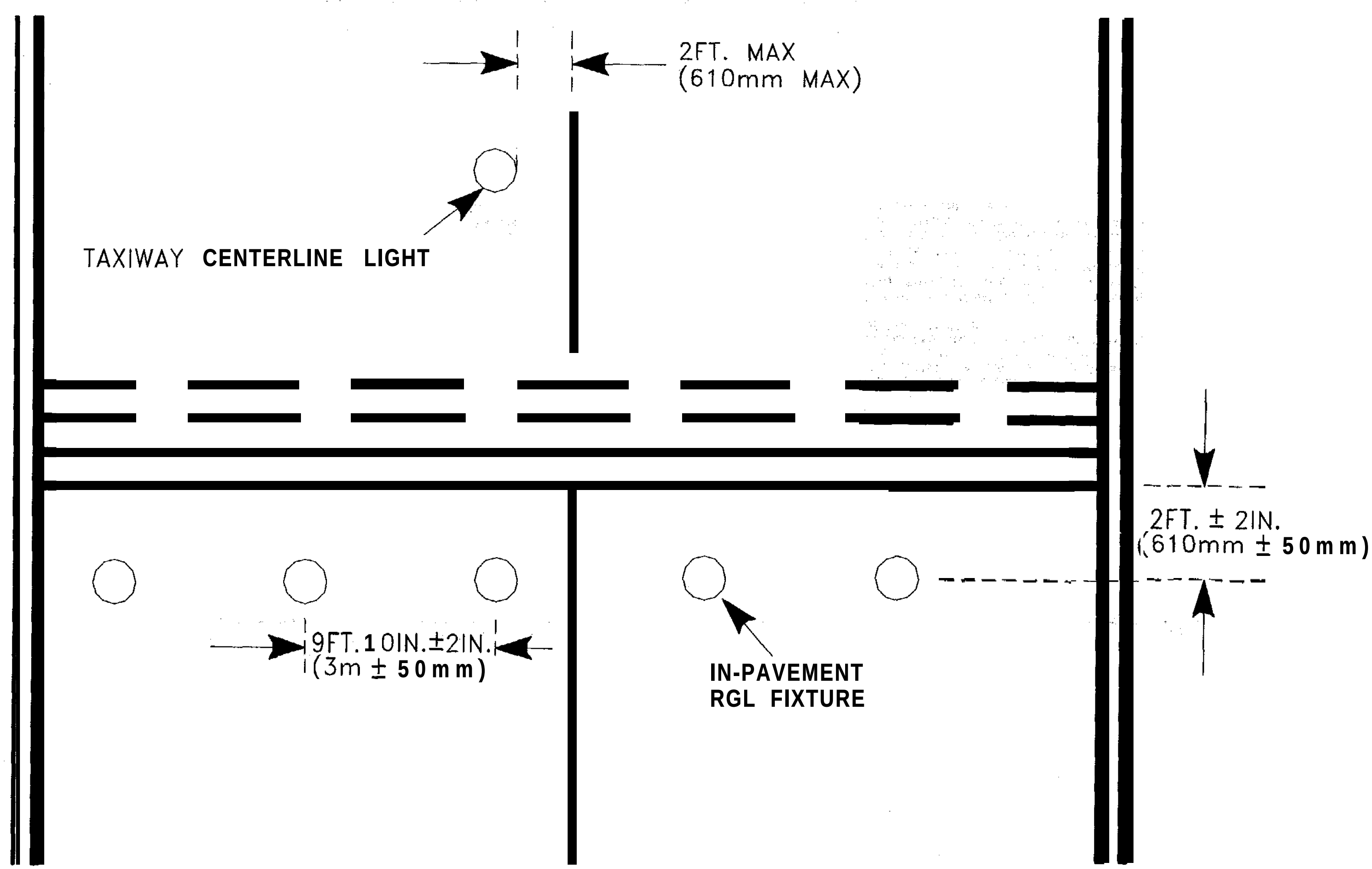


FIGURE 7. IN-PAVEMENT RUNWAY GUARD LIGHT CONFIGURATION

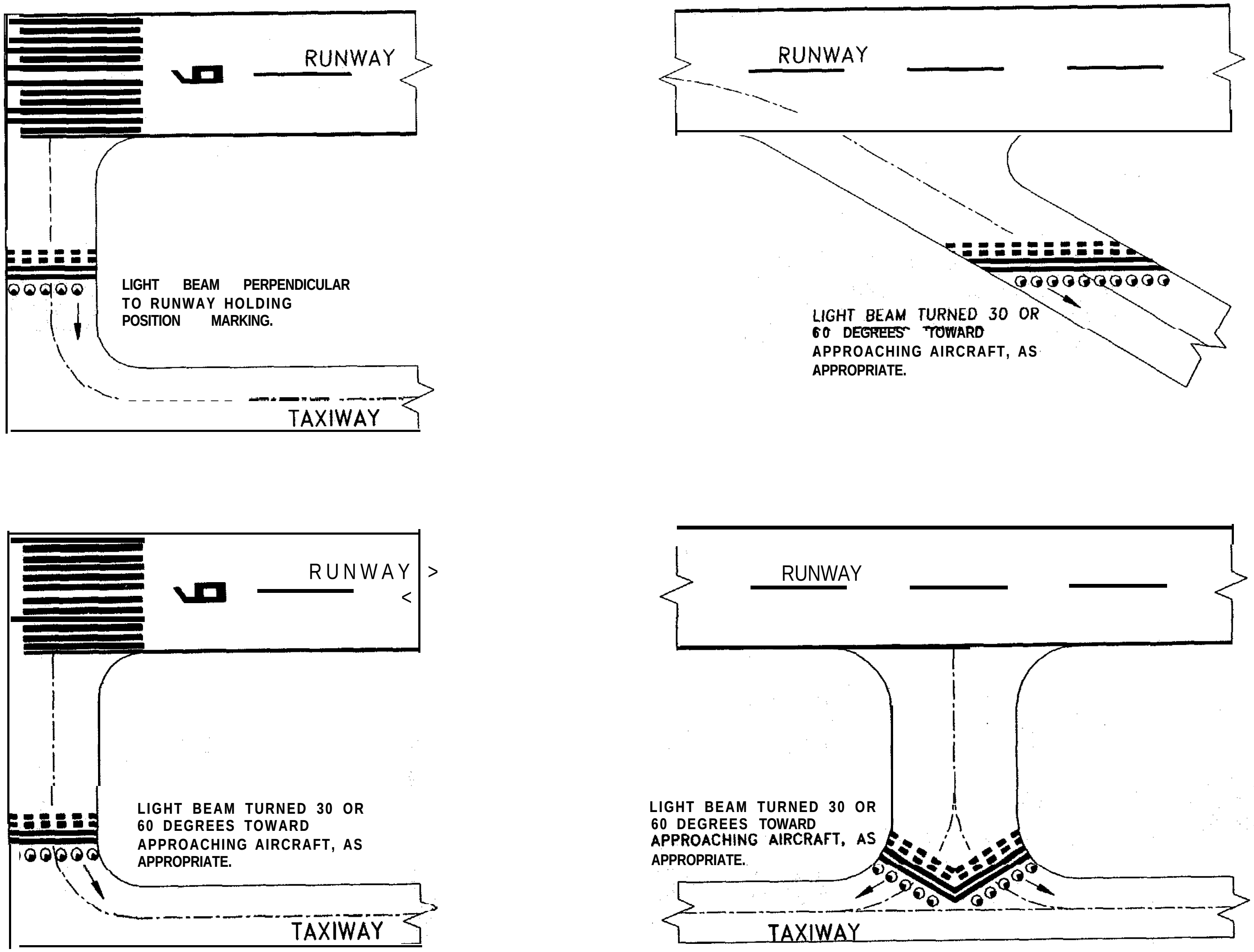
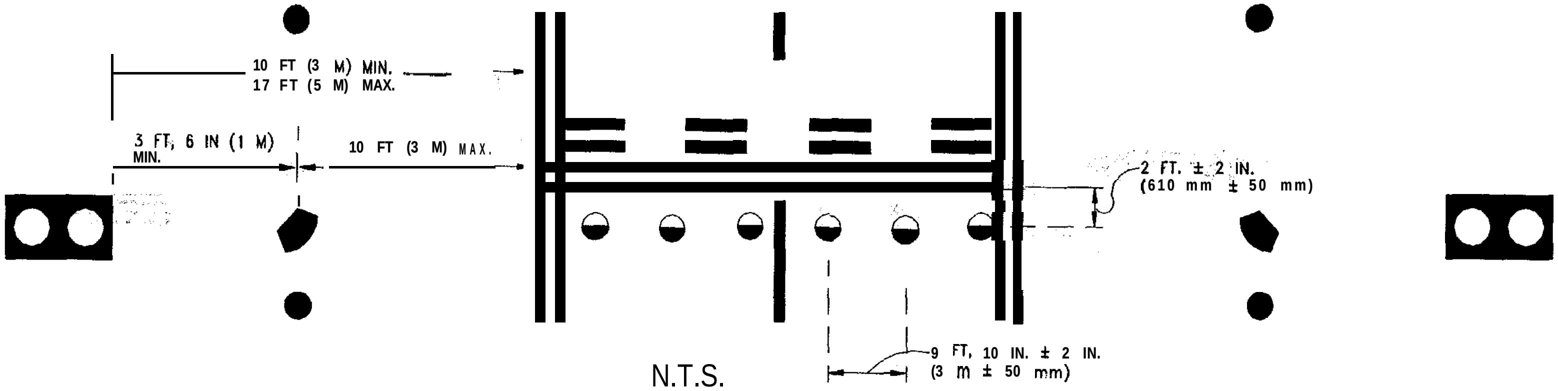


FIGURE 8. TYPICAL LIGHT BEAM ORIENTATION FOR IN-PAVEMENTRGLs AND STOP BARS



LEGEND

IN-PAVEMENT STOP BAR FIXTURE

ELEVATED STOP BAR FIXTURE

TAXIWAY EDGE LIGHT

ELEVATED RUNWAY GUARD LIGHT

NOTES

1. THE ELEVATED RUNWAY GUARD LIGHT AND ELEVATED STOP BAR MAY BE MOVED UP TO 10 FEET (3 M) MAX. AWAY FROM THE RUNWAY TO AVOID UNDESIRABLE SPOTS.

2. WHERE SNOW REMOVAL OPERATIONS OCCUR, IT IS ADVANTAGEOUS TO INSTALL ELEVATED STOP BAR LIGHTS NOT CLOSER TO THE TAXIWAY EDGE THAN THE LINE OF TAXIWAY EDGE LIGHTS.

FIGURE 9. ELEVATED RGL AND STOP BAR LIGHT CONFIGURATION

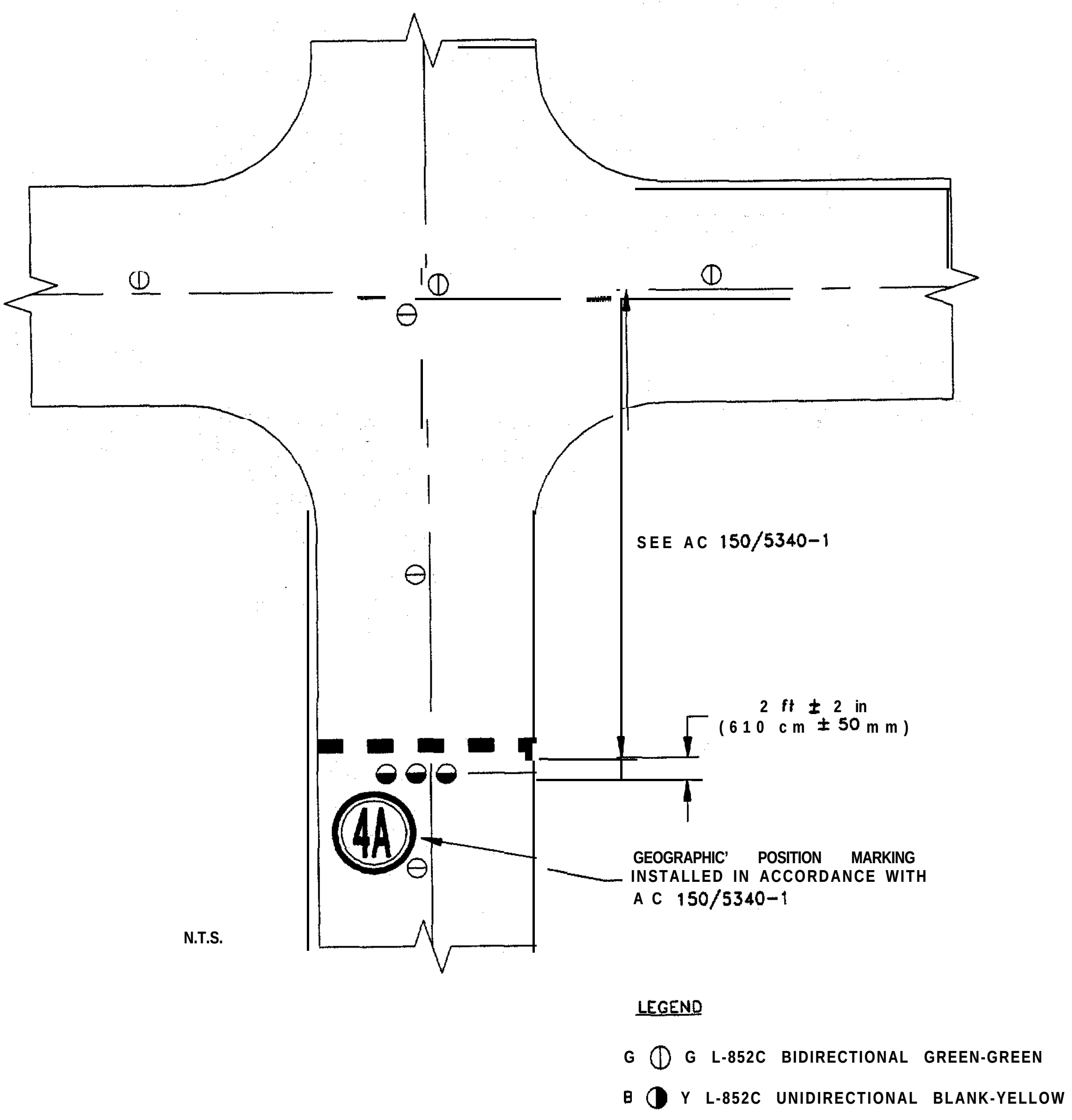
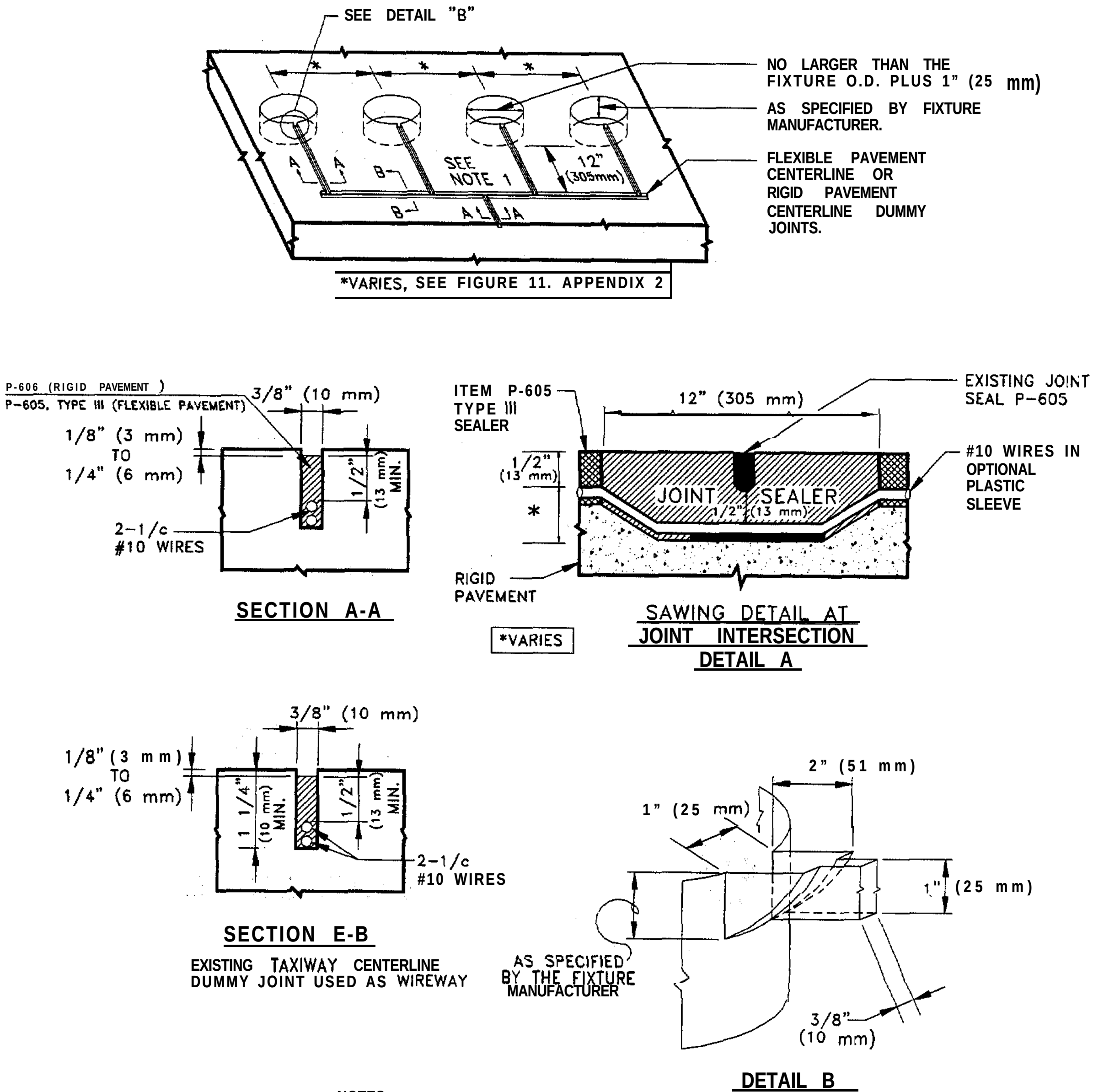


FIGURE 10. CLEARANCE BAR CONFIGURATION AT A LOW VISIBILITY HOLD POINT



NOTES:

1. WIRES ARE NOT LESS THAN 1/2" (13 mm) BELOW JOINT SEAL COMPOUND.
2. WHEN THERE IS NO EXISTING DUMMY CENTERLINE JOINT SAW LONGITUDINAL WIREWAY IN ACCOROANCE WITH SECTION A-A.
3. DETAIL B IS FOR BASE-MOUNTED FIXTURES ONLY. USE SECTION A-A FOR DIRECT MOUNTED FIXTURES.

FIGURE 11. SAWING AND DRILLING DETAILS FOR IN-PAVEMENT TAXIWAY CENTERLINE LIGHTS

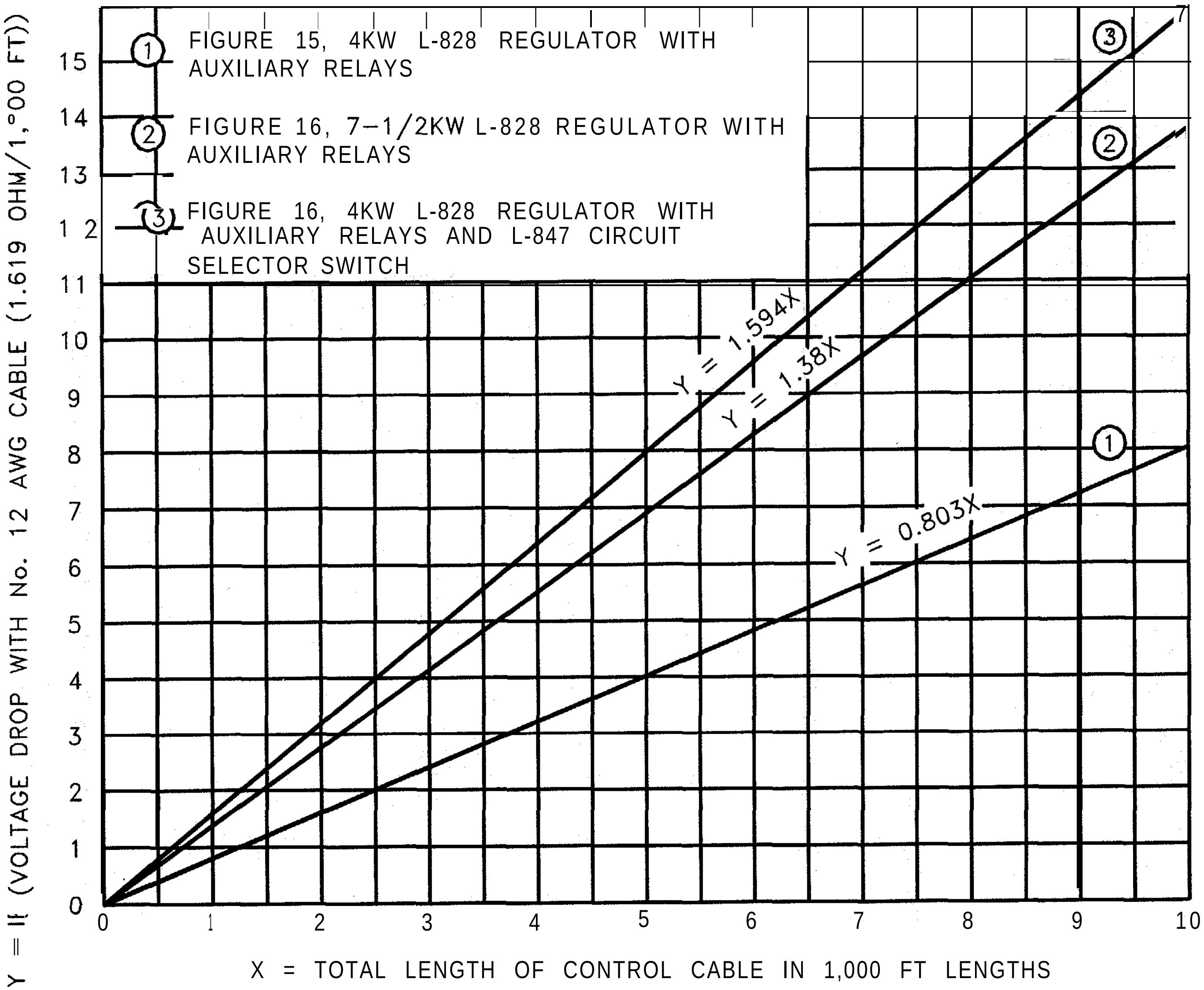
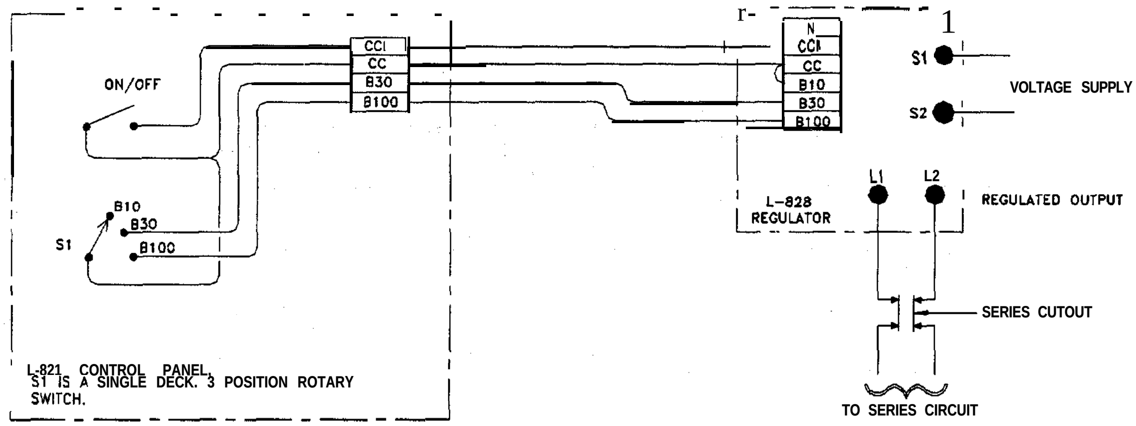
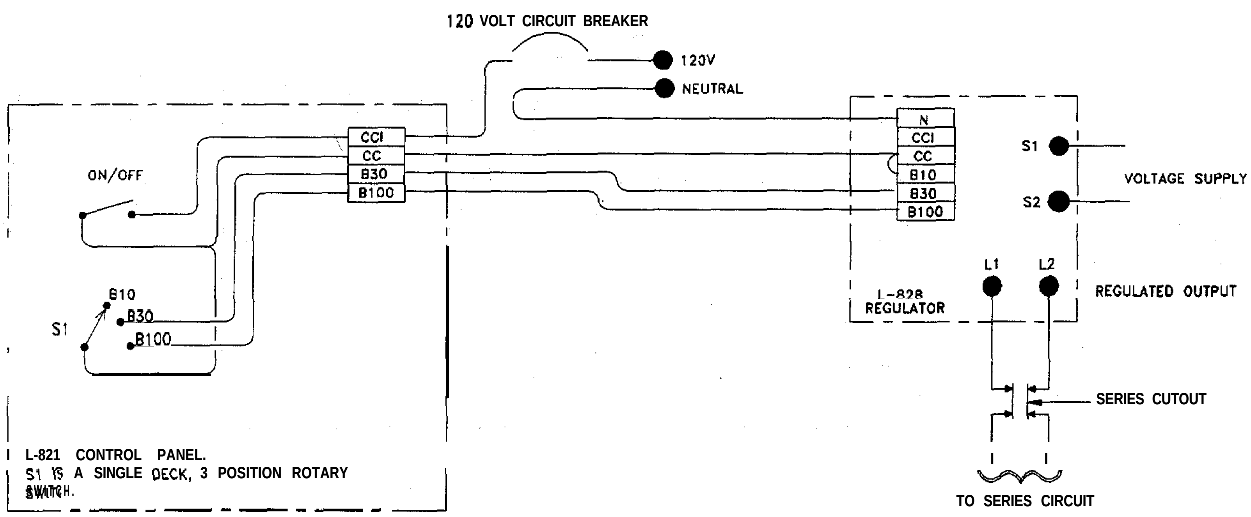


FIGURE 13. CURVES FOR DETERMINING MAXIMUM SEPARATION BETWEEN VAULT AND CONTROL PANEL WITH 120-VOLT AC CONTROL

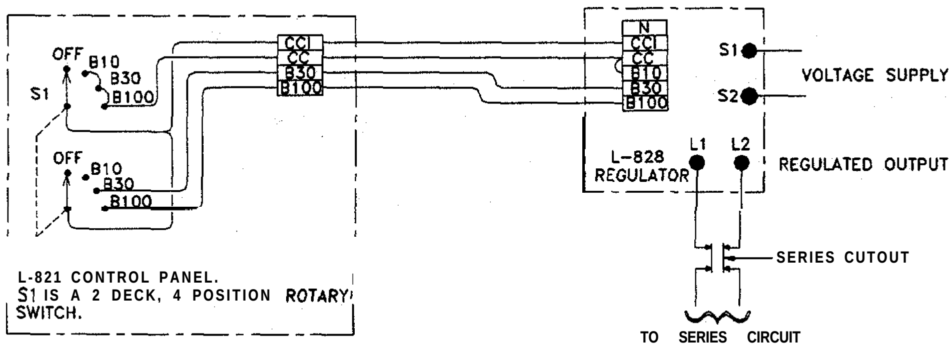


TAXIWAY REGULATOR IN BASIC CONTROL CONFIGURATION USING REGULATOR'S INTERNALLY-SUPPLIED CONTROL VOLTAGE.

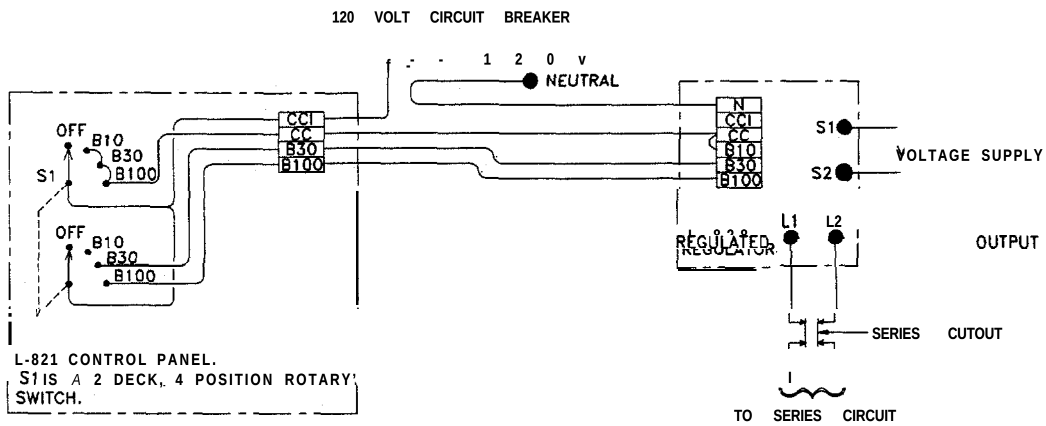


TAXIWAY REGULATOR IN BASIC CONTROL CONFIGURATION USING EXTERNALLY-SUPPLIED CONTROL VOLTAGE.

FIGURE 14. TYPICAL BASIC 120 VAC REMOTE CONTROL SYSTEM



TAXIWAY REGULATOR CONTROL CONFIGURATION USING REGULATOR'S INTERNALLY-SUPPLIED CONTROL VOLTAGE.



TAXIWAY REGULATOR CONTROL CONFIGURATION USING EXTERNALLY-SUPPLIED CONTROL VOLTAGE.

FIGURE 15. ALTERNATIVE 120 VAC REMOTE CONTROL SYSTEM

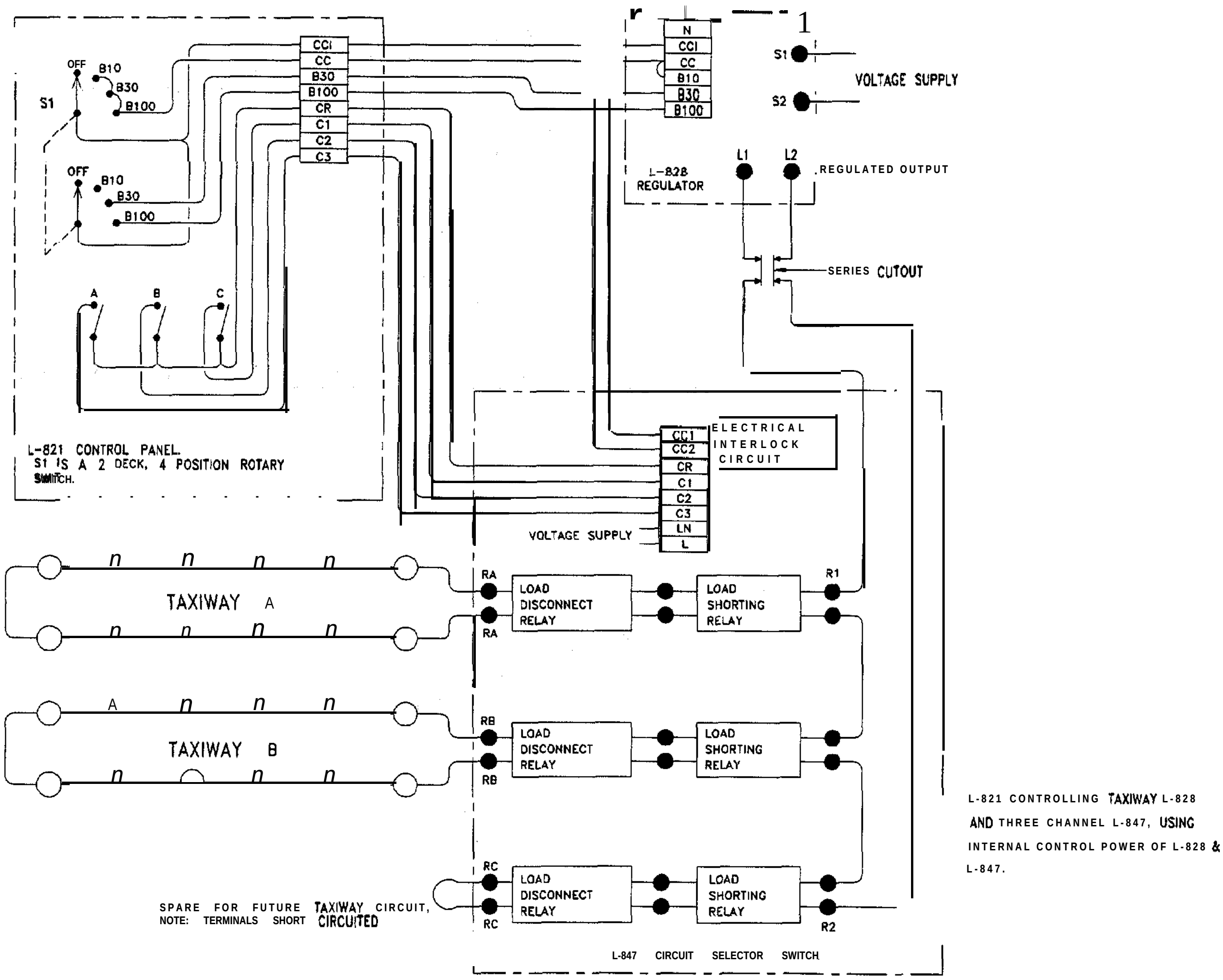
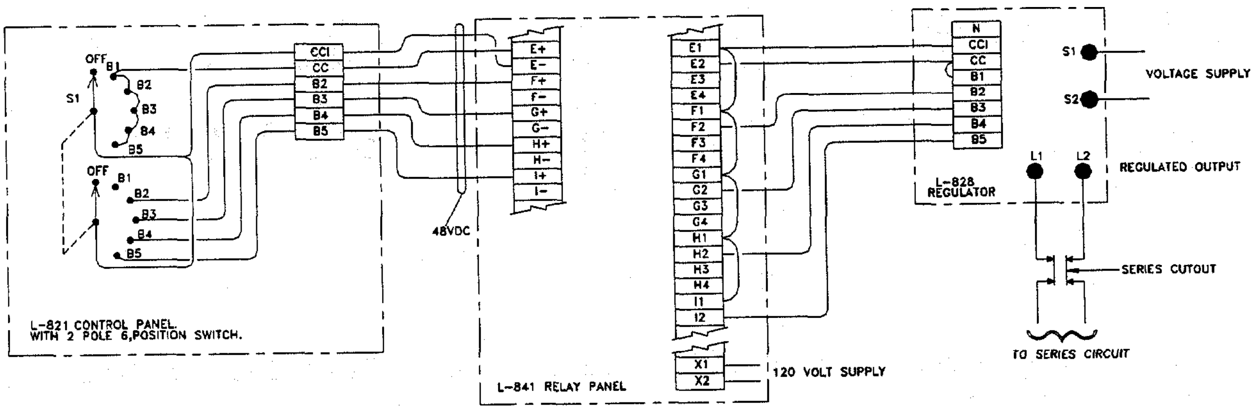
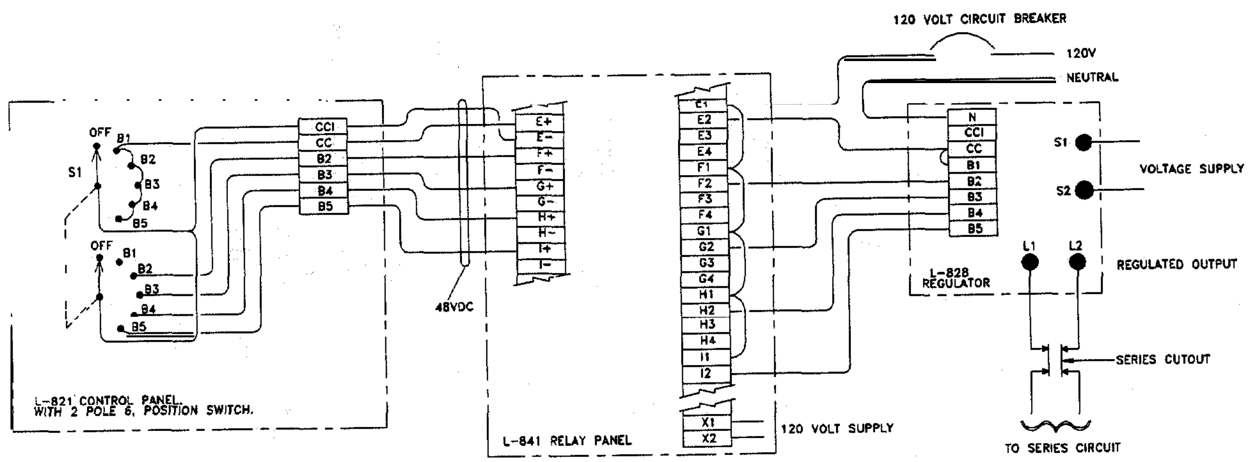


FIGURE 16. TYPICAL 120 VAC REMOTE CONTROL SYSTEM WITH L-847 CIRCUIT SELECTOR SWITCH

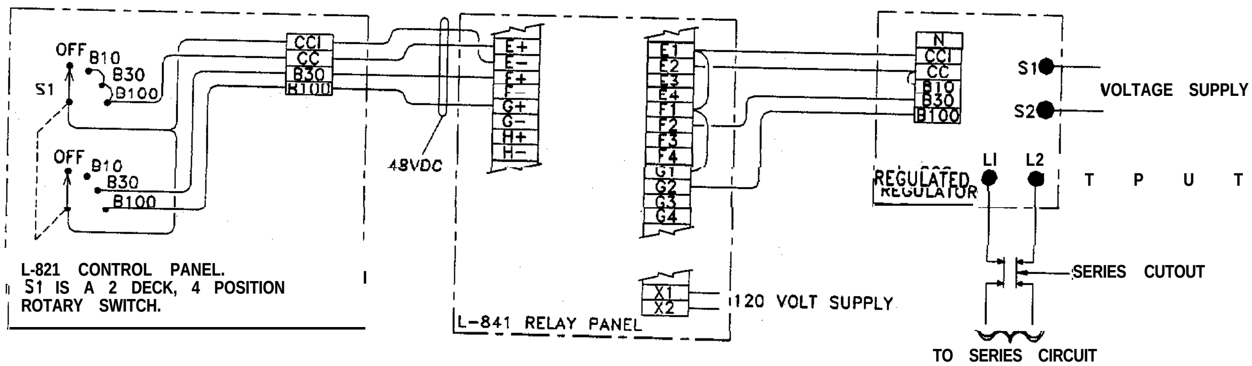


TAXIWAY REGULATOR CONTROL CONFIGURATION USING L-841, 48VDC, AND REGULATOR'S INTERALLY-SUPPLIED CONTROL VOLTAGE.

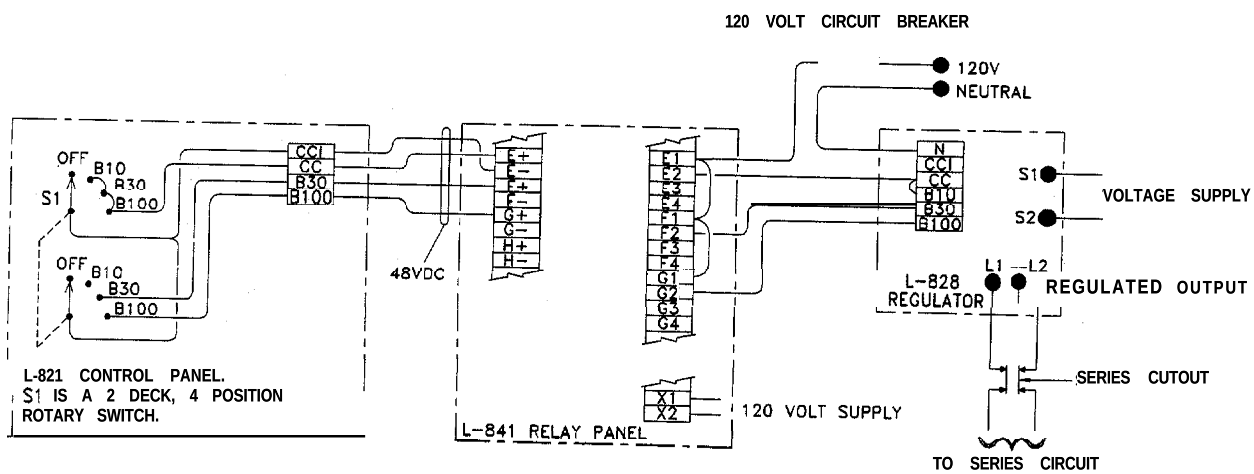


TAXIWAY REGULATOR CONTROL CONFIGURATION USING L-841, 48VDC, AND EXTERNALLY-SUPPLIED CONTROL VOLTAGE.

FIGURE 17. TYPICAL 48 VDC REMOTE CONTROL SYSTEM WITH 5-STEP REGULATOR AND L-841 RELAY PANEL



TAXIWAY REGULATOR CONTROL CONFIGURATION USING L-841. 48 VDC, AND REGULATOR'S INTERNALLY-SUPPLIED CONTROL POWER.



TAXIWAY REGULATOR CONTROL CONFIGURATION USING L-841, 48VDC, AND EXTERNALLY-SUPPLIED CONTROL POWER.

FIGURE 18. TYPICAL 48 VDC REMOTE CONTROL SYSTEM WITH 3-STEP REGULATOR AND L-841 RELAY PANEL

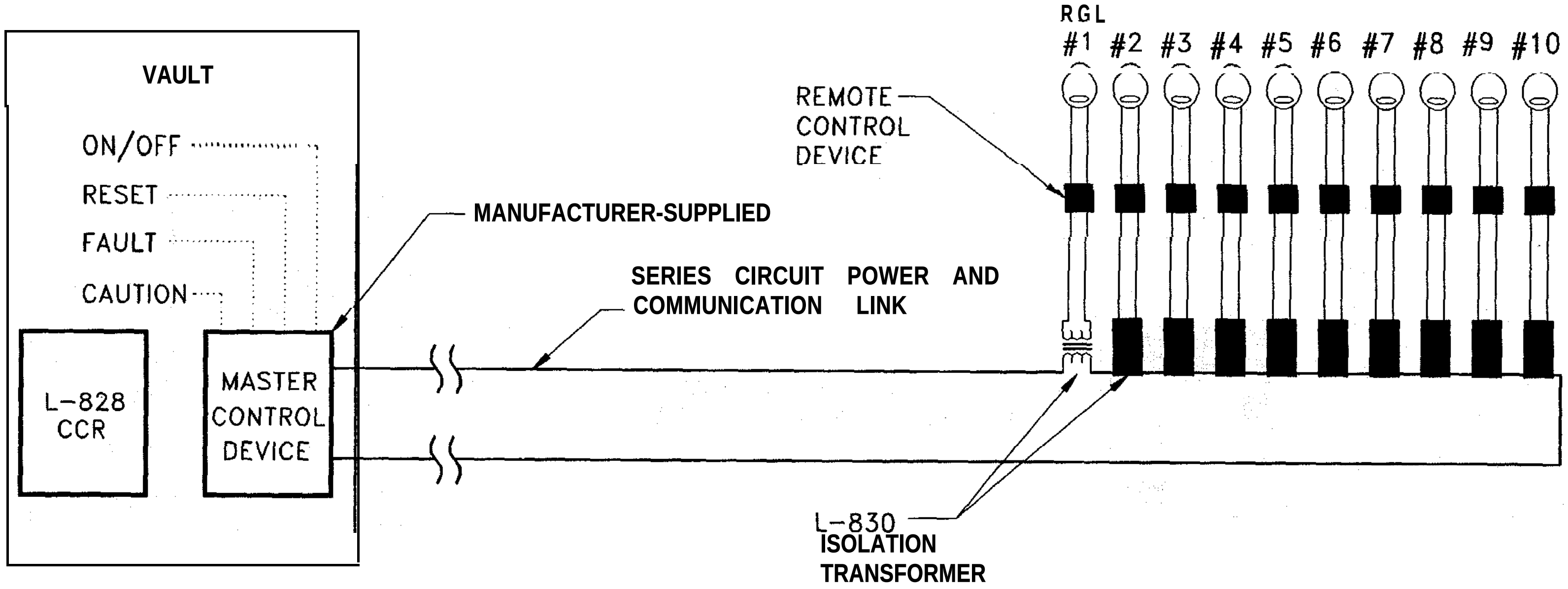


FIGURE 19. TYPICAL IN-PAVEMENT RGL EXTERNAL WIRING DIAGRAM - POWER LINE CARRIER COMMUNICATION. ONE LIGHT PER REMOTE

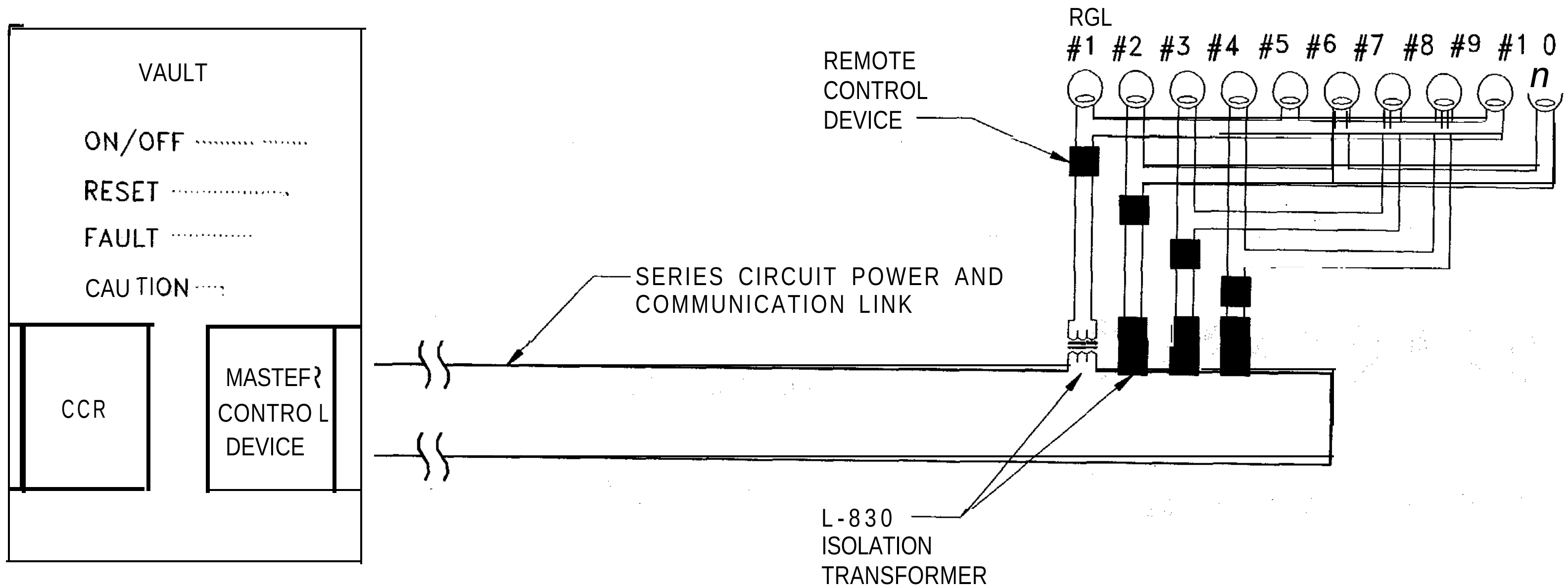


FIGURE 20. TYPICAL IN-PAVEMENT RGL EXTERNAL WIRING DIAGRAM -POWER LINE CARRIER COMMUNICATION, MULTIPLE LIGHTS PER REMOTE

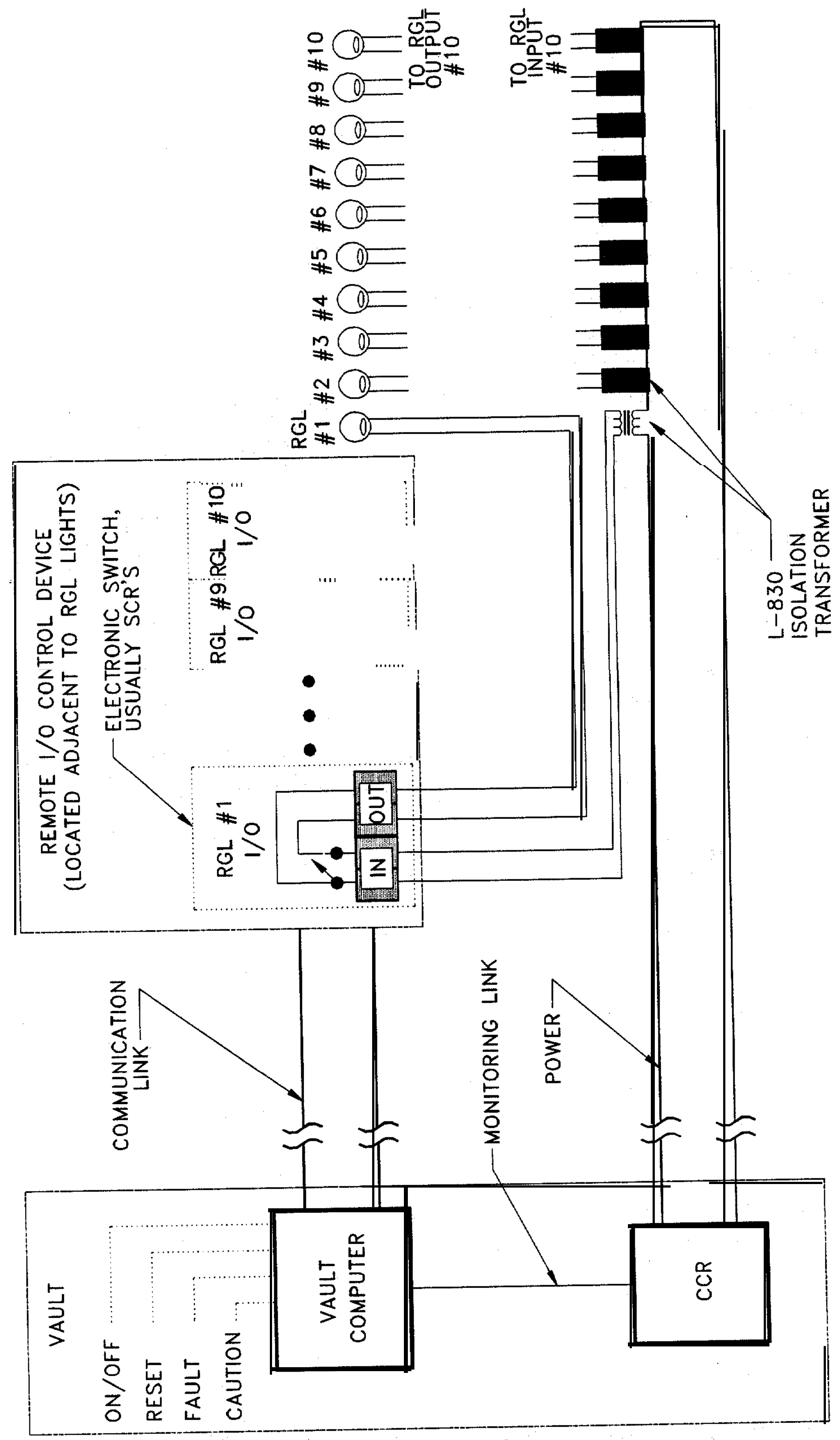


FIGURE 21. TYPICAL IN-PAVEMENT RGL EXTERNAL WIRING DIAGRAM – DEDICATED COMMUNICATION LINK

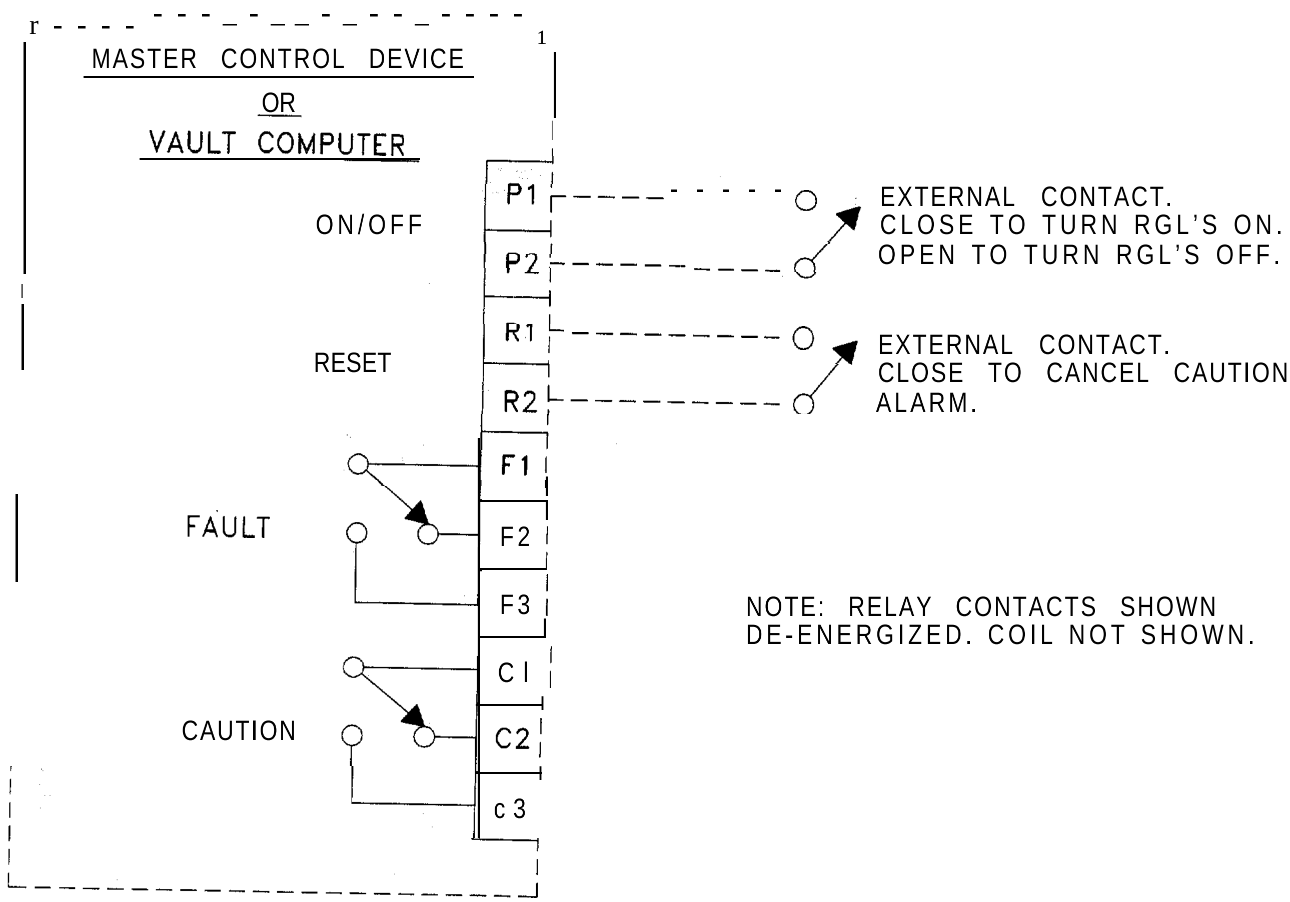
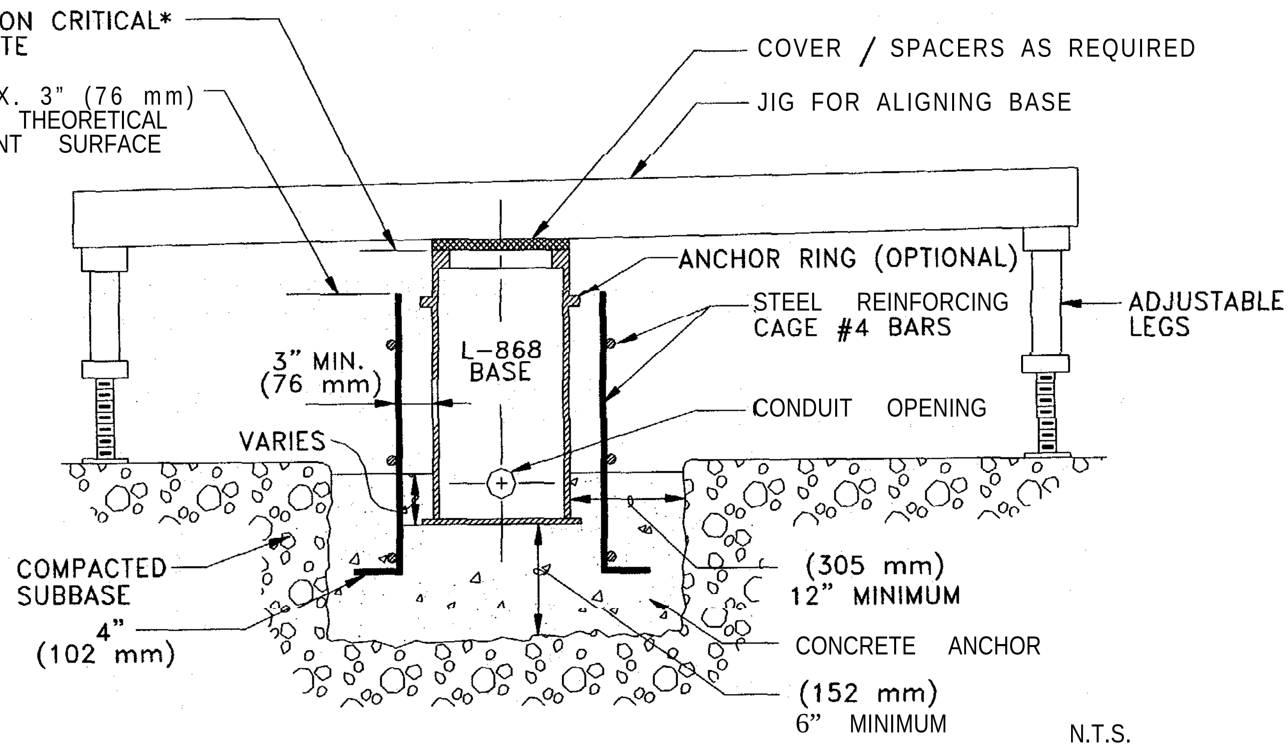


FIGURE 22. IN-PAVEMENT RGL ALARM SIGNAL CONNECTION



NOTE:

BASE MUST BE POSITIONED TO PERMIT PASSAGE OF PAVING MACHINE AND TO ACCOMMODATE FLANGE RING AND FIXTURE. IF THE BASE ELEVATION IS SET TOO HIGH IT WILL INTERFERE WITH PAVING OPERATIONS AND RESULT IN COSTLY CORRECTIVE ACTION. IF THE BASE IS SET TOO LOW, THICKER FLANGE RINGS OR SPACER RINGS CAN BE USED FOR CORRECTIONS. IN SETTING THE BASE ELEVATION, ALLOW FOR AT LEAST 1/2 INCH (13 mm) VARIATION IN THEORETICAL PAVEMENT SURFACE ELEVATION PLUS 1/4 INCH (6 mm) ADDITIONAL SAFETY MARGIN.

FIGURE 23. USE OF ALIGNMENT JIG, NO REFERENCE EDGE AVAILABLE, BASE AND CONDUIT SYSTEM

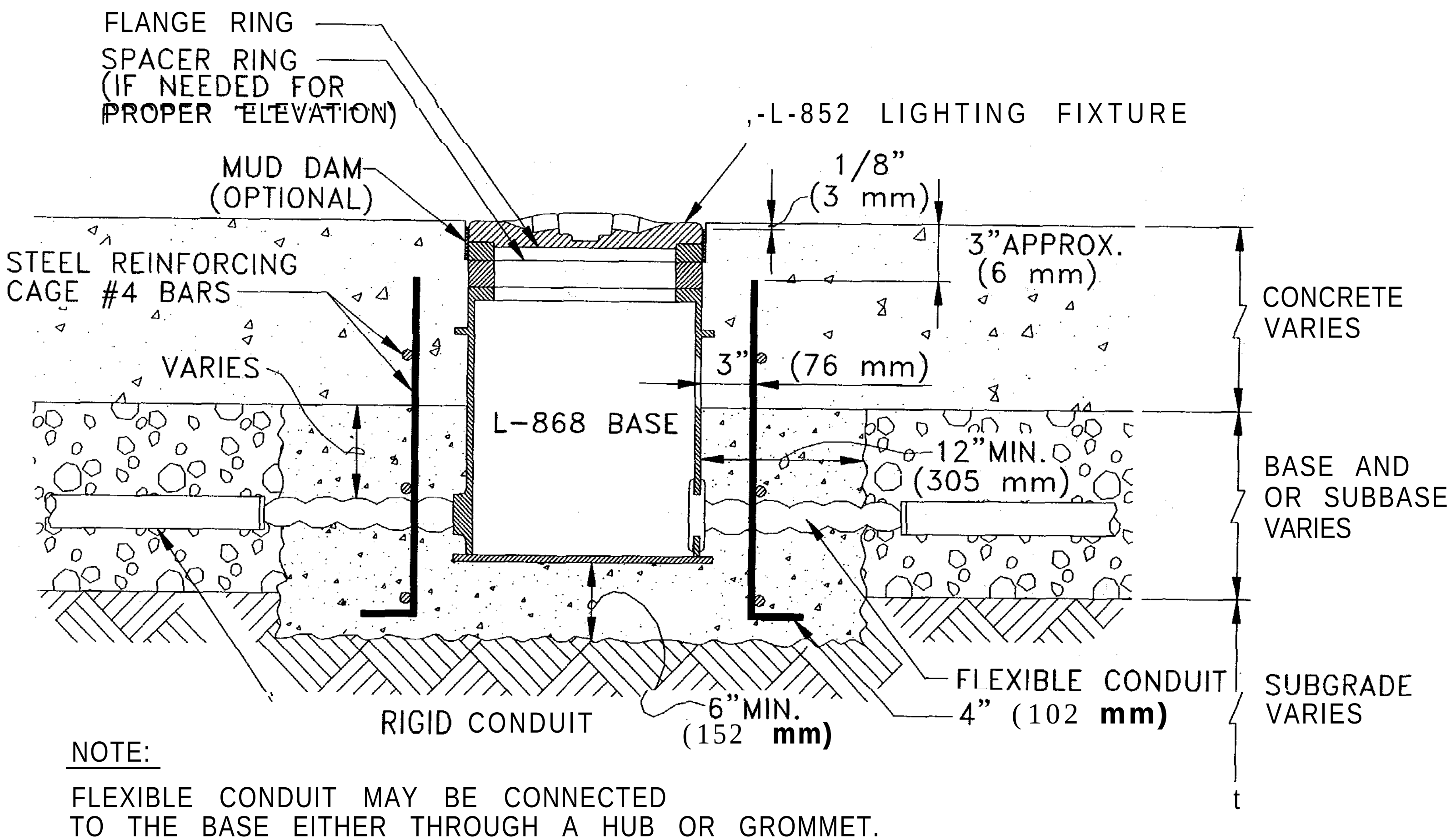
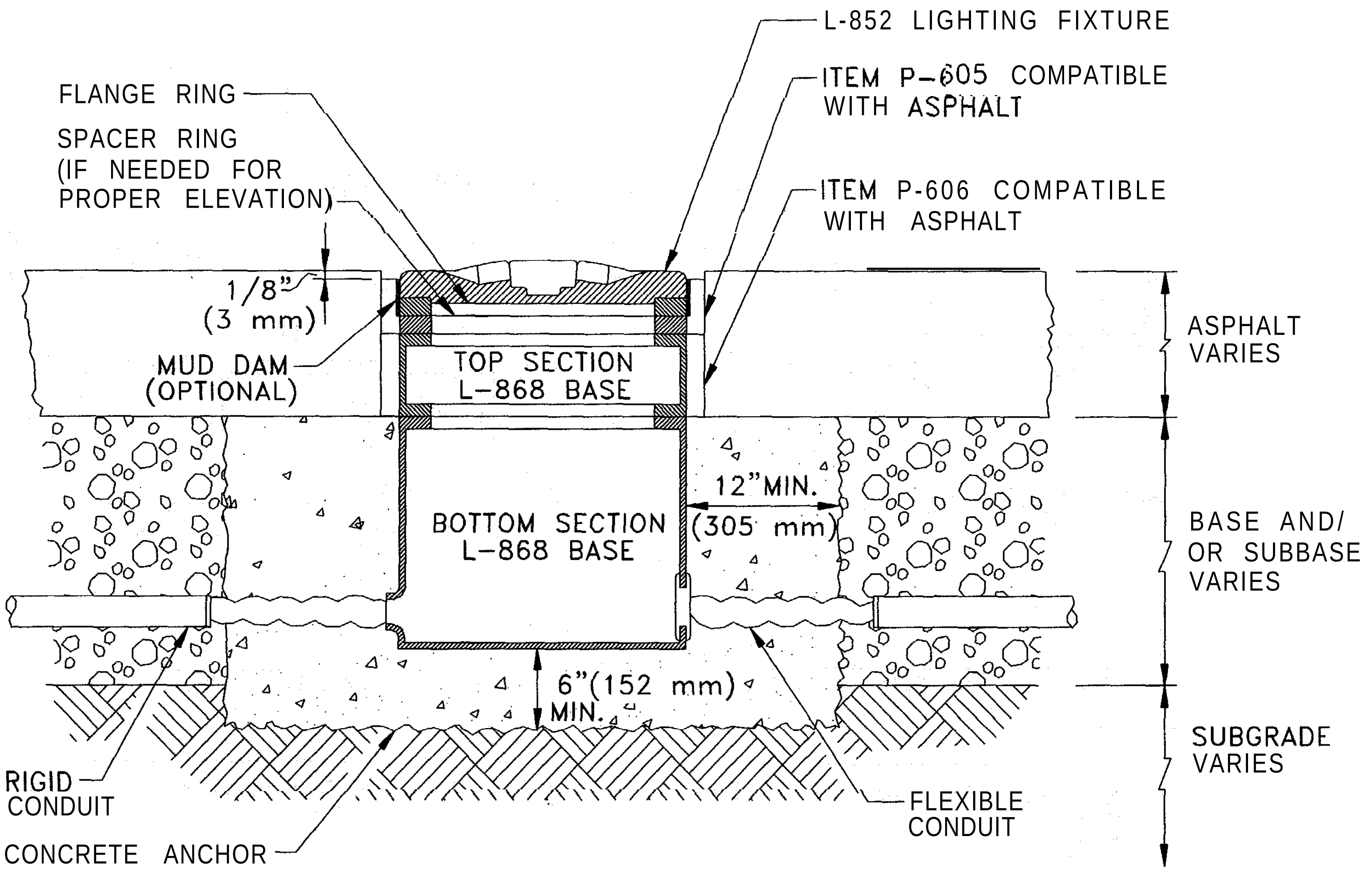


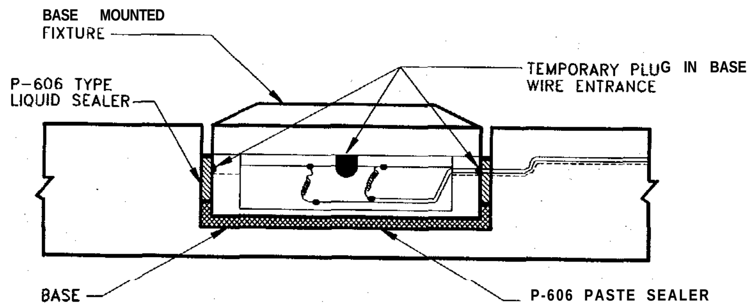
FIGURE 24. SECTION THROUGH BASE AND ANCHOR, BASE AND CONDUIT SYSTEM, RIGID PAVEMENT



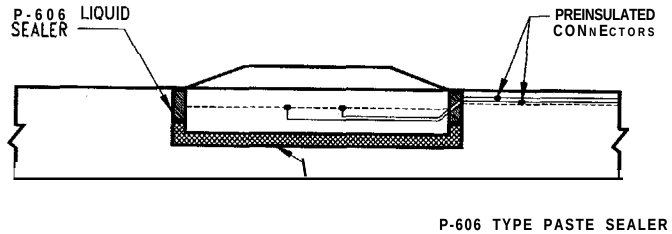
NOTE:

FLEXIBLE CONDUIT MAY BE CONNECTED TO THE BASE EITHER THROUGH A HUB OR GROMMET.

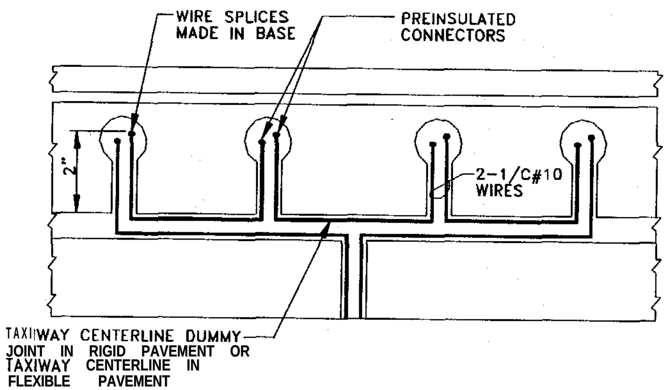
FIGURE 25. SECTION THROUGH BASE AND ANCHOR, BASE AND CONDUIT SYSTEM. FLEXIBLE PAVEMENT



BASE-MOUNTED LIGHT ASSEMBLY



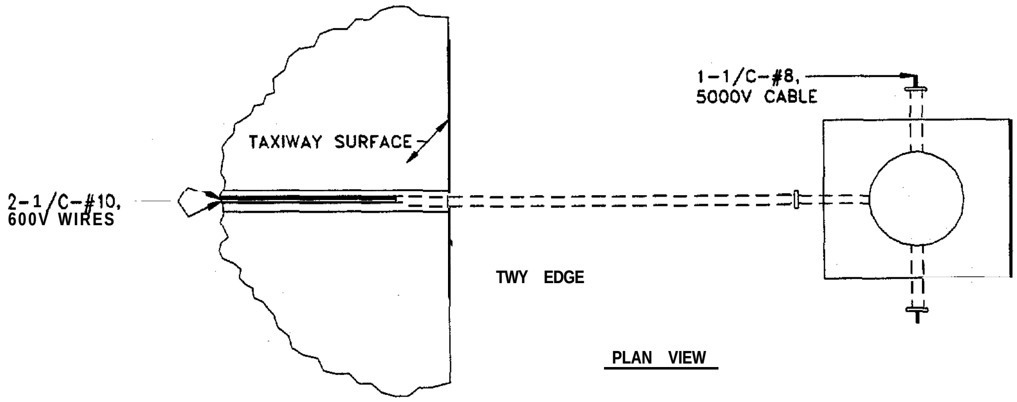
DIRECT-MOUNTED LIGHT ASSEMBLIES



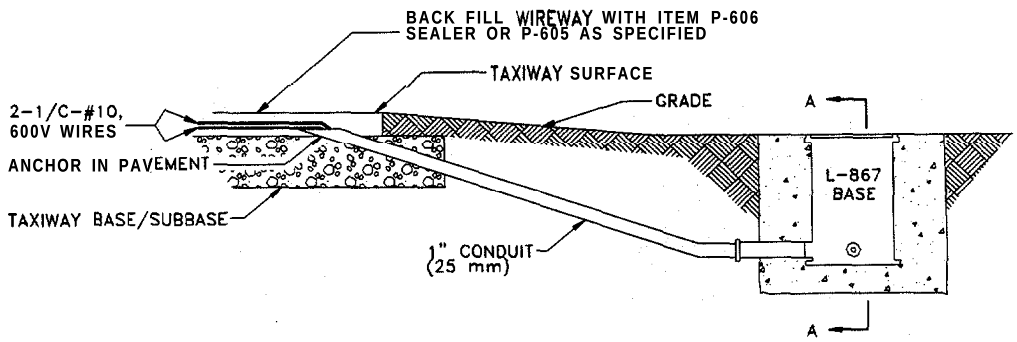
WIRING DIAGRAM FOR BASE-MOUNTED LIGHT ASSEMBLY

WIRING DIAGRAM FOR DIRECT-MOUNTED LIGHT ASSEMBLIES

FIGURE 26. WIRING DETAILS FOR DIRECT- AND BASE-MOUNTED TAXIWAY CENTERLINE LIGHTS

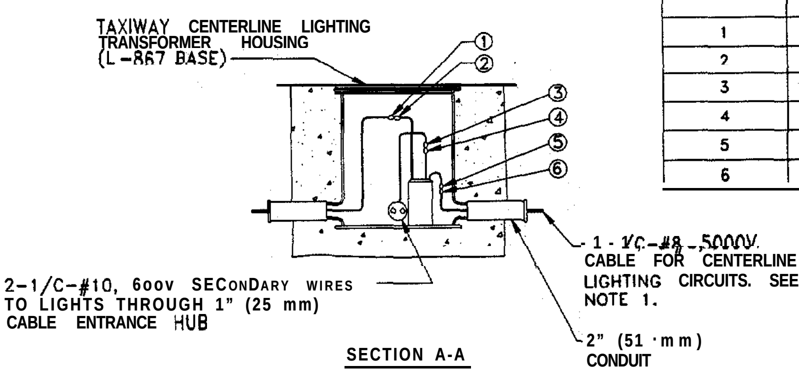


PLAN VIEW



PROFILE

CONNECTOR	L-823 CONNECTORS SEE AC 150/5345-26
1	RECEPTACLE, CLASS B, TYPE I, STYLE 10
2	PLUG, CLASS A, TYPE I, STYLE 2
3	PLUG, CLASS B, TYPE II, STYLE 4
4	RECEPTACLE, CLASS A, TYPE II, STYLE 8
5	RECEPTACLE, CLASS A, TYPE I, STYLE 9
6	PLUG, CLASS B, TYPE I, STYLE 3



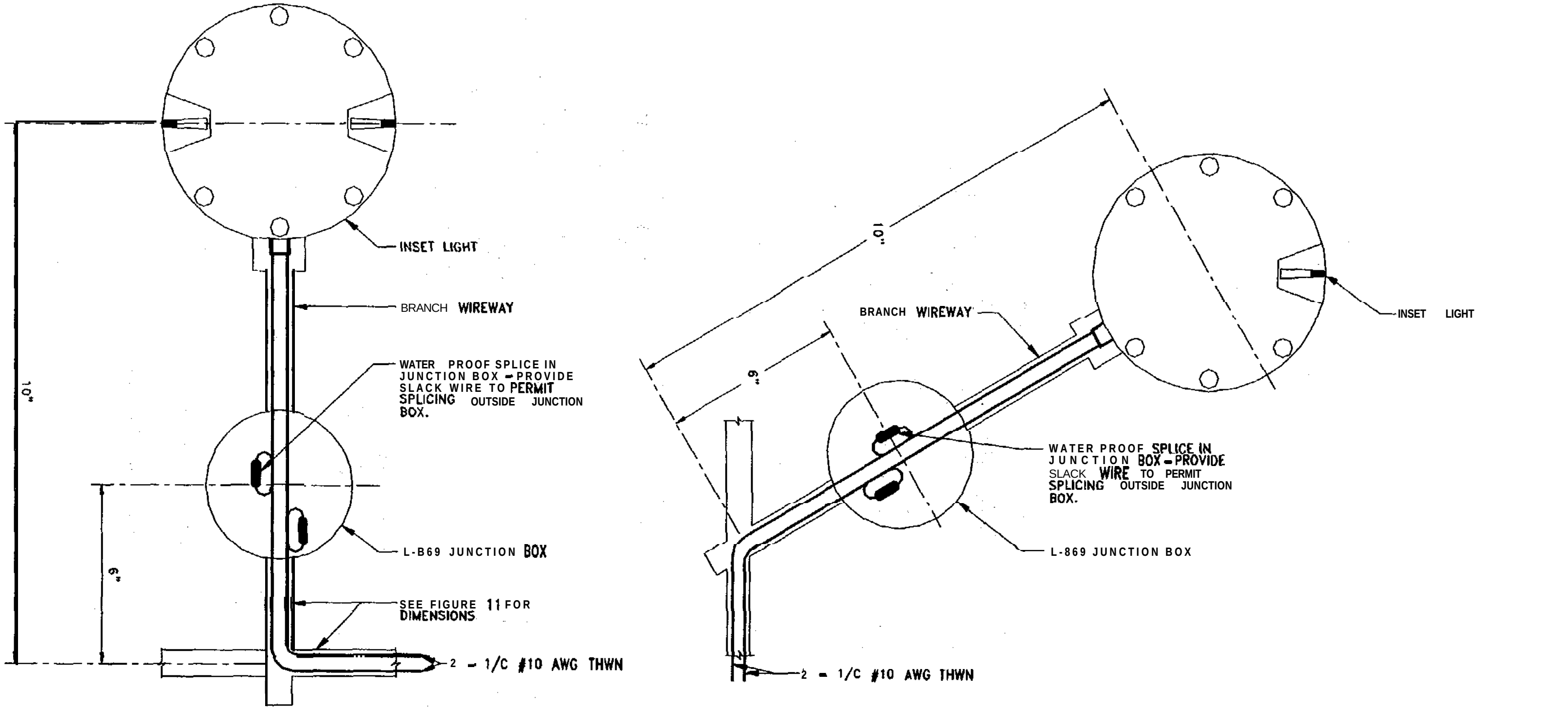
SECTION A-A

NOTES:

1. THE PRIMARY CABLES ARE INSTALLED IN ACCORDANCE WITH ITEM L-108 OF AC 150/5370-10.

2. THE L-867 LIGHT BASE AND TRANSFORMER ARE INSTALLED IN ACCORDANCE WITH PARAGRAPH 10C.

FIGURE 27. TYPICAL TRANSFORMER HOUSING AND CONDUIT INSTALLATION DETAILS FOR TAXIWAY CENTERLINE LIGHTS



NOTES :

1. EITHER CONFIGURATION UAY BE USED, AS REQUIRED BY THE MANUFACTURER.

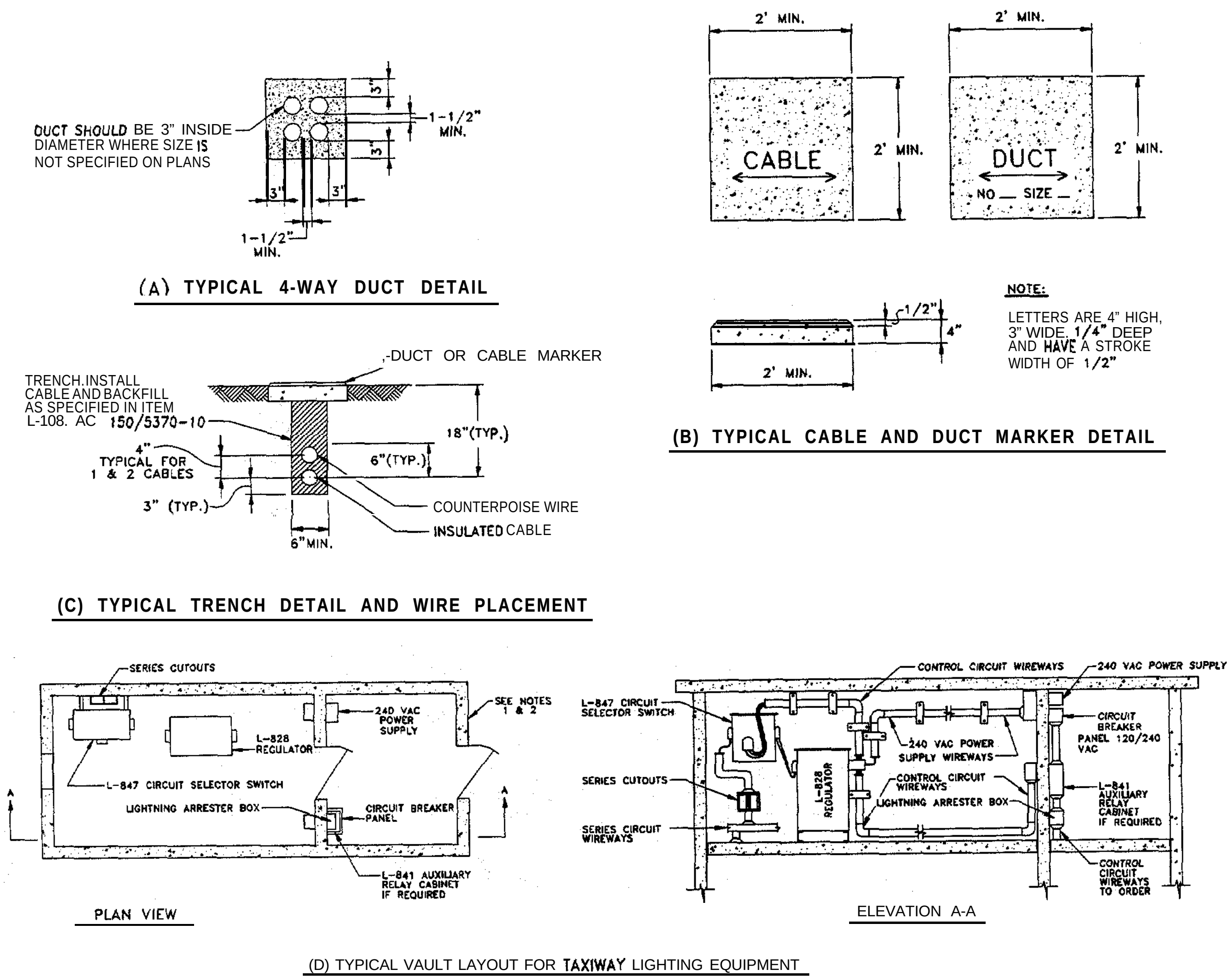
2. PROVIDE METAL TO METAL CONTACT BETWEEN THE TOP COVER AND THE BASE OF THE JUNCTION BOX.

3. FILL JUNCTION BOX WITH A COMMERCIAL NON-SETTING MATERIAL THIS MATERIAL IS USED TO PREVENT WATER FROM COLLECTING IN THE JUNCTION BOX.

4. PROVIDE A SUITABLE GASKET AND GROMMETS TO CONTAIN NON-SETTING MATERIAL IN JUNCTION BOX.

5. INSTALL THE JUNCTION BOX LEVEL WITH THE SURROUNDING PAVEMENT.

FIGURE 28. JUNCTION BOX FOR INSET FIXTURE INSTALLATIONS



NOTES:

1. VAULT CONSTRUCTION AND EQUIPMENT INSTALLATION ARE IN ACCORDANCE WITH TNE NATIONAL CODE, LOCAL CODES, ITEM L-109 OF AC 150/5370-10.
2. AN ADEQUATE NUMBER OF LIGHTING FIXTURES AN0 ELECTRICAL OUTLETS SHOULD BE PROVIDED IN THE VAULT.
3. THE UNDERGROUND ELECTRICAL DUCTS AND DUCT MARKERS ARE SPECIFIED IN PLANS. THE INSTALLATION OF DUCTS AND MARKERS ARC IN ACCORDANCE WITH ITEM L-110 OF FAA AC 150/5370-10.
4. THE METRIC EQUIVALENT (IN mm) MAY BE FOUND BY MULTIPLYING INCHES BY 25.4.

FIGURE 29. TYPICAL VAULT, FIXTURE DUCT, TRENCHING, AND DUCT AND CABLE MARKING DETAILS

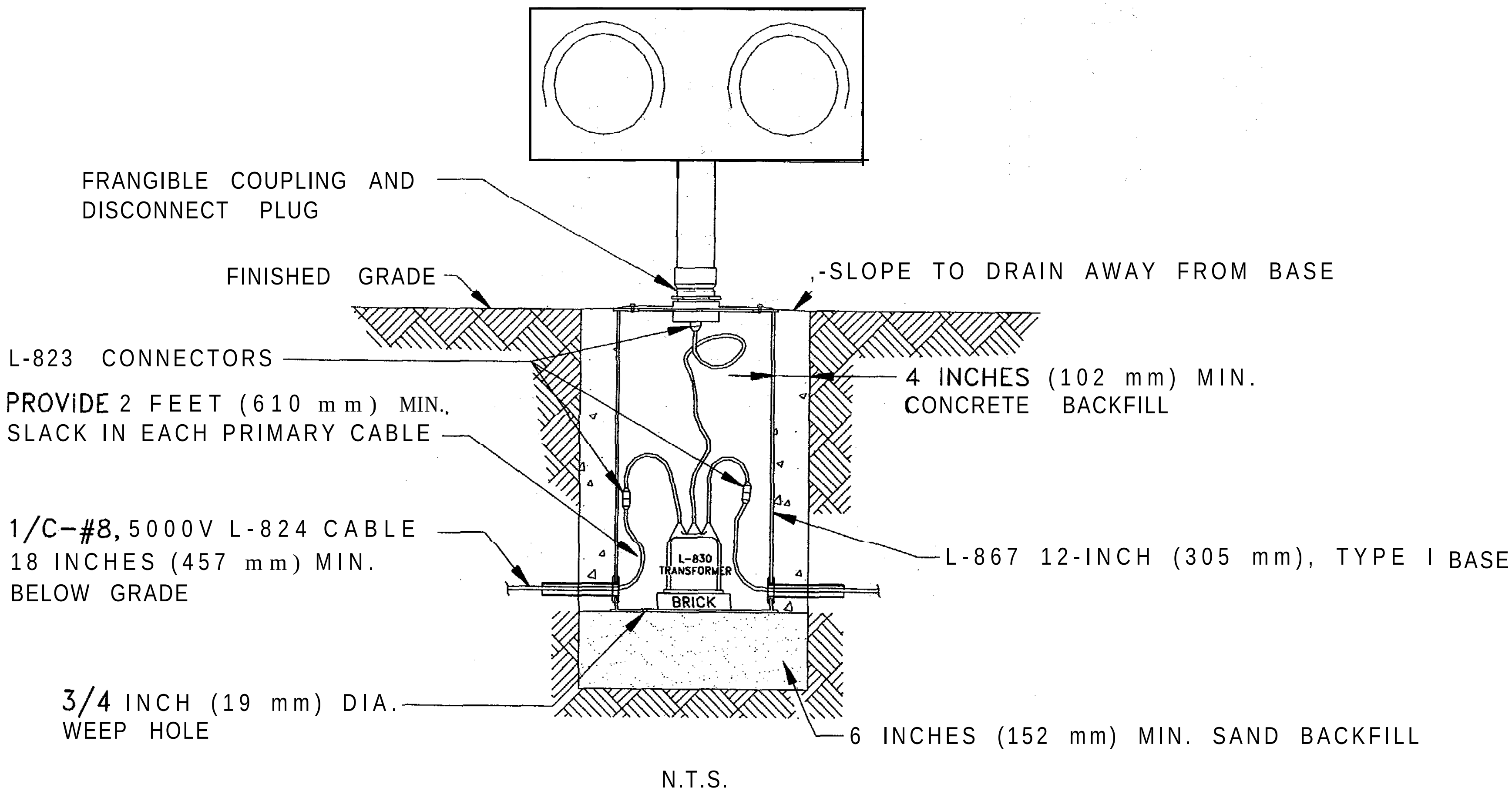


FIGURE 30. TYPICAL ELEVATED RGL INSTALLATION DETAILS

U.S. Department
of Transportation

Federal Aviation Administration

800 independence Ave., SW
Washington, D.C. 20591